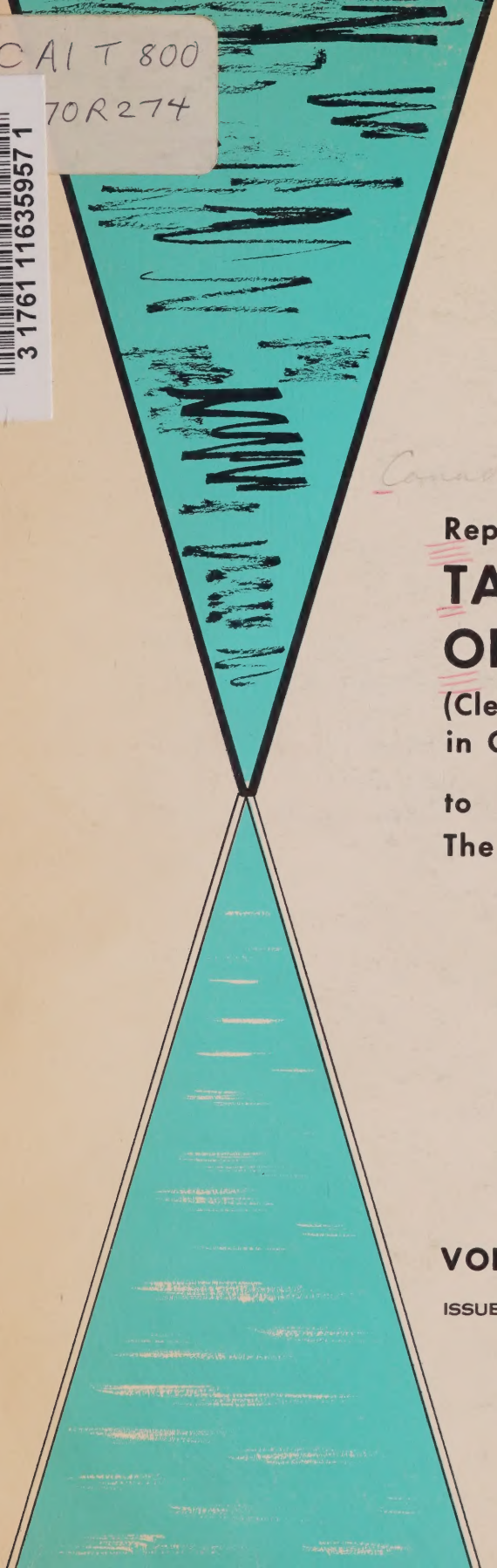

Report of the

TASK FORCE - OPERATION OIL

(Clean-up of the Arrow oil spill in Chedabucto Bay)

to

The Minister of Transport

VOLUME IV

ISSUED BY THE MINISTRY OF TRANSPORT

Report of the

TASK FORCE - OPERATION OIL

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The Minister of Transport

Cat. No.: T22–2473/4

OPERATION OIL

VOLUME IV

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Ottawa, Canada

23 May, 1972

The Hon. Don Jamieson, P.C., M.P.,
Minister of Transport,
Ottawa, Canada.

Dear Mr. Minister:

The three volume report of your Task Force on Operation Oil which we presented to you on the 1st of September, 1970, covered our field operations up to July 1970, and, while we had perhaps broken the back of the job, there was still a very considerable mess in Chedabucto Bay which had to be cleaned up.

In the succeeding 22 months those working on the clean-up for us had had some substantial successes which we feel should be reported to you and, through publication, hopefully be made available to those elsewhere in the world who may have similar misfortunes. In addition, we have some unsolved problems which we would like to highlight so they can become the foci for ongoing research.

The beach cleaning operations were handled most efficiently by the Department of Public Works and we would like to bring to your attention very specifically our commendations of their Halifax Regional Office and the engineers who supervised the work both for the main effort during the spring and summer of 1970 and throughout the spring, summer and autumn of 1971.

In September of 1970 there was a most successful re-pump of the tanks in the stern section of the Arrow and another 100,000 gallons of Bunker C were recovered. Further improvements were made in the technology base for the recovery of oil from sunken tankers.

There was a fairly substantial slick-licking operation to recover mixtures of oil and eel grass in Inhabitants Basin during the spring and early summer of 1971.

Navigation was re-established in the Canso Tickle by the removal of the Tickle Dam in April of 1971 without incurring any new oil contamination below the dam site.

We left the Lennox Passage Dam in place through the 1971-72 winter because there was still a strip of about three miles of coastline on the north side of Lennox Passage with active oil on it. We felt the risk of this oil being entrained in the winter ice and, if the dam was removed, carried eastward onto clean beaches, was sufficient to justify leaving the dam in until the spring of 1972. We carried out a complete survey of the Bay during the first week in May 1972 and there appears to be no need for further slick-licking or beach cleaning this year within Chedabucto Bay. The nationally rated beaches and the community beaches are in good shape. The oil in Lennox Passage has stabilized to the point where it no longer constitutes a hazard and we have asked the Regional Office of Public Works in Halifax to have the dam opened by the July 1st week-end.

Two areas outside the Bay will require ongoing attention. Black Duck Cove beach is still badly fouled with oil chunks which have moved out of the adjacent rock filled lagoon. The oil in this lagoon is still active and there is no point in trying to clean the sand beach until this oil is stabilized. We still have need for much research on the process of stabilization so that at present our judgment is only slightly better than a guess, but we think it will likely be the summer of 1974 before it will be worth cleaning this beach.

The second area is Louse Island. This uninhabited island, which can only be reached by boat or helicopter and has no community beaches, was contaminated probably at the same time as Black Duck Cove. The island is mainly bedrock shore with a scant covering of soil and scrub in the centre. The Bunker C is still lying in pools three to six inches deep in hollows in the bedrock. This oil is covered with a very thin oxidized layer, but under the action of the sun this layer is penetrated, revealing oil which gives the same appearance as it had in the spring of 1970, i.e., no apparent stabilization. Where the oil has been splashed on the trees or on the top of the rocks it has hardened as elsewhere. No clean-up of this area is warranted but it should be kept under observation for scientific reasons.

As these two areas can be handled by your pollution control officers, who are familiar with both areas, we suggest that our work as a Task Force on Operation Oil be considered terminated with the removal of the Lennox Passage Dam.

With regard to action being taken on the recommendations we presented to you in Volume I of our report in September, 1970, there are four aspects which cause us concern:

(1) We were delighted with the passage of your Bill C-2 to amend the Canada Shipping Act and felt that it caught the essence of our experience. We have seen a few drafts of the concomitant regulations and, unless there is some substantial re-direction, we feel that the strength and intent of Bill C-2 might be eroded by timid and archaic regulations to the point where international merchant shipping will continue its sloppy ways in Canadian waters with impunity. We suggest that this was not the intent of Bill C-2.

(2) We understand that the responsibility for funding research and development in scientific and engineering projects to improve our capabilities of dealing with oil spills rests with the Department of the Environment. To date very little money seems to have been made available, insufficient, in fact, to follow up on problems identified during our operations. It is important that funds be made available to finance those projects in the physical and life sciences which are fundamental to our improved understanding and capabilities.

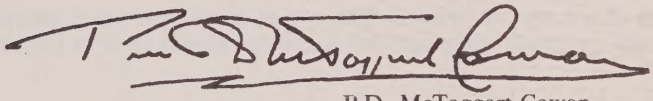
(3) We understand that the responsibility for prevention and clean-up rests with officers of your Ministry, while the money to support relevant research and to design, develop and test new equipment and improve existing equipment is in the budget of the Department of the Environment. We suggest that this will be a satisfactory arrangement only if your departmental officers have a major voice in the allocation of the financial support. There is evidence of unwarranted delays and frustrations which will do anything but encourage Canadian industry to develop skills in the area. We are sure that these projects will be pushed with the vigour necessary to ensure early completion if your officials with the responsibility for clean-up have a major involvement in the decisions.

(4) We would again urge that your headquarters pollution contingency team be strengthened with the addition of scientists, one from the physical sciences and another from the life sciences.

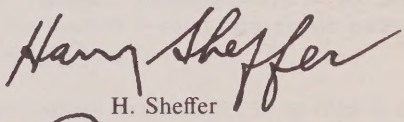
A vigorous research program to improve our understanding of the problems involved in oil clean-up is essential, but so is the development and production of better equipment for prevention, containment and clean-up to facilitate field operations.

Tankers twenty times the size of the Arrow are now in regular operation. Canada has a growing number of superports for these supertankers. There is a growing body of data which suggests that portions of the world's oceans are now chronically polluted with oil. There are, we suggest, no grounds for complacency, because tankers large and small continue to foul the shores of all the seas with monotonous regularity.

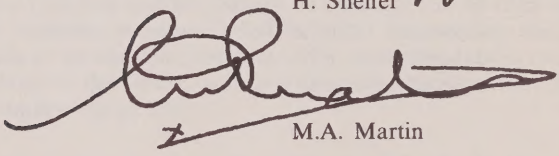
Yours sincerely,



P.D. McTaggart-Cowan



H. Sheffer



M.A. Martin

PART 2 – SUMMARY OF RECOMMENDATIONS

1. We recommend a substantial expansion of the scientific and engineering effort in R & D, particularly in industry and universities, in the environmental effects of oil pollution and methods of prevention, containment, and clean-up. (page 7)

2. We recommend that the officers in the Ministry of Transport who are responsible for clean-up should have a major voice in the funding of the engineering development of equipment concerned with prevention, containment and clean-up. (page 7)

3. We stress the urgency of research and development leading to a satisfactory way of disposing of the oil on the beach material and slick-licker debris by combustion. (page 10–11)

4. We recommend that the dumpsites should be re-visited in about five years' time in order to determine the extent of biodegradation which has taken place over that period. (page 10)

5. We recommend that when Ministry of Transport helicopters are in the area (Chedabucto Bay) for any purpose and the weather is calm they should observe and report on the amount of iridescence. (page 12)

6. We recommend that new practices and procedures be developed to be used in the investigation of marine accidents to ensure a full technical, engineering, scientific and operational diagnosis of an accident, complete with recommendations on how to prevent similar accidents in the future, and that these investigations be carried out prior to the judical inquiry. (page 20)

7. Positive en route and approach control of all merchant ships should become a world standard without delay. (page 21)

PART 3 – SUMMARY OF OPERATIONS

Introduction

Our previous reports (Volumes I,II, and III Operation Oil) gave details of our operations up to and including July 1970. Since then, the principal areas of activity have been beach cleaning, slick-licking, the re-pump of the stern section of the Arrow, the operation of dumpsites, and the maintenance and removal of the Canso Tickle and Lennox Passage Dams.

Competent people were in charge of each one of these operations so that the occasional telephone consultation with the Head of the Task Force, and visits by him to Chedabucto Bay at the close of operations in the autumn of 1970, prior to the opening of operations in the spring of 1971, following the close of operations in the fall of 1971, and in May 1972 was the extent of the operational involvement of the Task Force.

The Task Force maintained direct responsibility for the claims for damages and the requests for assistance by the residents and property owners of Chedabucto Bay and would like to publicly acknowledge the patience and courtesy of these people as we struggled to do the best we could for them.

There has been an ongoing scientific program guided and largely financed by the new federal Department of the Environment but with some of the programs supported by grants in aid from the National Research Council of Canada. As the results of these research programs will be published in the scientific literature in due course, this report will not deal with them. Those readers wishing to get advance information on the nature and progress of the research programs are invited to write to Dr. William Ford, Director of the Atlantic Oceanographic Laboratory at the Bedford Institute, or those of his colleagues who are mentioned in Volume II of the report of the Task Force.

Without in any way denigrating the quality of this work, it is insufficient in quantity and most of it is internalized in government laboratories. In fact, we understand that the amount of government money to fund general research in this area is actually less this year than last. *We recommend a substantial expansion of the scientific and engineering effort in R & D, particularly in industry and universities, in the environmental effects of oil pollution and methods of prevention, containment, and clean-up.*

Development of new and improved operational equipment to aid in future clean-up has not progressed as fast as we would wish. We are aware of a number of good proposals that have been put forward to the federal government but few of these have been funded. We suggest there are deficiencies in the funding mechanisms that have been established, with their roots in the fact that the Ministry of Transport have the clean-up responsibilities while the Department of the Environment have the research and development funding responsibilities. *We recommend that the officers in the Ministry of Transport who are responsible for clean-up should have a major voice in the funding of the engineering development of equipment concerned with prevention, containment and clean-up.*

Beach Cleaning

During the initial stages of Operation Oil certain beach cleaning experiments were conducted by the Canadian Forces. By April 24th, 1970, the responsibility for beach cleaning had been transferred to the federal Department of Public Works who had assigned on-site engineers to work under the general direction of the Task Force. Under the able direction of these engineers the techniques of beach cleaning were developed soundly and quickly.

The report prepared by John W. MacKay, the engineer who had the major responsibility for conducting this operation, is included as Appendix A because we feel the documented experience therein will be of considerable value to others faced with similar responsibilities.

Initially we were aided by the advice of coastal geomorphologists, particularly Mr. E.H. Owens. We will not refer to their report in detail because it has been published elsewhere. Suffice it to say that with their help we were able to identify the sensitive beaches in advance of our clean-up operation. On occasion, when the sensitivity of the beach to erosion was high, clean material was trucked in to replace the soiled material that had been removed. On other beaches rip-rap was placed to stop erosion which had been going on for some years but which might otherwise have been speeded up by the cleaning operation. On most of the beaches the soiled material could be removed with impunity.

The Public Works engineers found that the most efficient way to clean the lightly polluted beaches was to use gangs of men, whom we designated "slick-pickers", with shovels and plastic bags. In this way only the soiled material was removed.

The critical engineering judgement was, of course, to decide when the pollution on the beach reached a sufficient extent that the use of machinery – bulldozers, front end loaders and trucks – became the most efficient means of cleaning, with a secondary decision as to whether these equipments could be rubber tired or whether the nature of the beach required the use of tracked vehicles. The method of operating the vehicles proved to be most important. The cost effectiveness as well as the speed of clean-up operation depended critcially on the engineer making these judgements, on the spot and on time.

The Emergency Measures Organization officers working with the Task Force provided a most important service by moving out ahead of the beach cleaning operation to get waivers signed by those owning property fronting on cleanable beaches so that the Task Force could move equipment and men over the property with the owners' consent. It is a tribute to those living in Chedabucto Bay that the Task Force was refused access on only one or two out of many hundred such requests.

By the time the beach cleaning operation was closed down for the winter of 1970-71, approximately 30 miles of tourist beach and community beach had been cleaned. Several beaches close to heavily polluted rock or boulder shorelines had had to be cleaned two or three times.

We had good co-operation from the Provincial Government and the Tourist Bureau so we were able to schedule our beach cleaning in line with the tourist season. Thus, as far as we can assess, no tourist visiting the area was inconvenienced by the presence of oil on any of the nationally rated beaches. It was inevitable, however, that some Chedabucto Bay children would continue to get oil in their hair, on their skin and over their clothing because, like children everywhere, they loved to play on large boulders and on the bedrock shores in preference to the adjoining sand or gravel beaches.

The boulder and bedrock shoreline was virtually uncleanable by the techniques developed for the Task Force. Even in retrospect we think our ban on the use of chemicals in Chedabucto Bay was correct but this must be tested by continuing research. Our testing and use of various kinds of stabilizing materials was of such marginal success that widespread operation was not justified. Continuing research into this problem should be assured. By leaving the boulder and bedrock shoreline for natural stabilization to take place we have to live with the consequent recontamination of adjoining tourist and community beaches.

By October the beaches were all in good shape but a helicopter survey of the area at that time showed that some of the gravel shorelines directly opposite Cerberus Rock were still heavily contaminated, so it was presumed that with the onset of the winter storms oil would be brought back into circulation through the normal erosion of these exposed beaches and would be re-deposited on the tourist and community beaches.

The Bay was re-surveyed by helicopter in March 1971 and a modest amount of recontamination was observed. As a result the Department of Public Works assigned engineer John Haikings to the job, and under his direction a survey of all beaches in the area was conducted by two university students who had been trained during our operations in 1970. Following this survey the clean-up work was authorized to commence immediately. Mr. Haikings assigned on-site responsibility for the cleaning operations to the two students, Mr. Bourque and Mr. MacInnis, and with local labour, mainly slick-pickers, all beaches were kept in good shape throughout the summer with the exception of Black Duck Cove. The sand beach at Black Duck Cove is immediately adjacent to a large rock-filled lagoon which was very heavily contaminated at the time of the original spill and which was virtually uncleanable with the techniques we had developed. Consequently on almost every high tide oil moved out of the lagoon onto the sand beach. The beach could have been kept usable by cleaning it almost every second day but the people who lived at Black Duck Cove agreed with our on-site supervisors that this would be a waste of money and the intelligent course of action was to wait until nature had stabilized the oil in the lagoon. The residents moved their summer swimming and recreation program to an adjoining cove. This is a typical example of the kind of co-operation the Task Force has received from all those who live in Chedabucto Bay and which made substantial contributions to the efficiency and economy of the whole operation.

The beach cleaning operation was closed for the autumn immediately after Labour Day.

The beaches were again inspected by helicopter on September 18th. It is not expected that there will be any requirement for beach cleaning in the spring of 1972. Black Duck Cove should be watched and as soon as the oil in the lagoon has finally stabilized the sand beach should be cleaned. This is likely to be the summer of 1974. Louse Island should be kept under surveillance for several years for scientific purposes.

Slick-licking

The operation of the slick-lickers to recover oil and oiled material from the surface of the water continued until August 1970, and as a result the detailed report of this operation could not be included in Volume III. It is now included as Appendix B to this report. The total amount of oil recovered by the operation during the spring and summer of 1970 was approximately 150,000 gallons. The amount of weed and debris which had to be picked up to recover the oil was, of course, prodigious.

Our inspection of the Bay in March 1971 showed that there had been a considerable aggregation of oiled eel grass in the Inhabitants Bay area during the winter. This was not unexpected because the Basin in Inhabitants Bay is correctly named and seems to be the ultimate cesspool for most water-borne contamination in the area. It is also the best growth area for eel grass.

Accordingly, Mr. Michael Greenham, of the Ministry of Transport, who had operated the slick-lickers with such distinction in the summer of 1970, returned with his equipment, with some modifications, and was in operation by the 21st of May 1971. The operation was scheduled to last five to six weeks and was started as late as possible to permit the natural accumulation of the oil in the Basin and yet early enough to ensure that this operation would be completed before the tourist season commenced.

The slick-licking operation was concluded on the 26th of June, by which time a further 10,000 gallons of oil had been recovered, most of it contained within a mixture of about 90 per cent eel grass and 10 per cent oil.

This area was inspected again in September 1971 and the shoreline was still free of oiled eel grass. As it had remained clean from the end of June to the end of September, through the hottest portion of the year, it was presumed that this problem would not recur during the winter of 1971-72 and that further slick-licking would not be required. The inspection of the area in May 1972 confirmed this.

A report on the 1971 slick-licking operation is included as Appendix C.

Dumpsites

The disposal of the substantial amount of soiled beach material and the considerable quantities of oil mixed with eel grass and all manner of debris picked up by the slick-lickers presented a problem.

Our first choice for disposal was by burning, but owing to the fact that the oil was in a water-in-oil emulsion and the percentage of combustible materials in most of the spoiled material was low, no form of combustion short of a full blast furnace was found to be practical. We were unable to design a portable blast furnace for the occasion in the time at our disposal. It must be remembered that a design of this kind would have to handle material which is up to 99 per cent non-combustible. We still feel frustrated that we were not able to innovate a good solution in this area, but time ran out and the material had to be disposed of, and so we must leave as a high priority for continuing research and development a portable blast furnace that could be taken on site and handle a wide variety of materials on a continuous combustion basis.

Continuous extraction and washing techniques should also be investigated. One of the problems of the blast furnace approach is that the percentage of combustibles is insufficient to sustain combustion itself when the oil is in a water-in-oil emulsion, and the temperature must be above 1000° F. to break down the emulsion.

The solution we chose was the use of carefully selected dump-sites. We arranged, with the excellent co-operation of the provincial government, for the very careful selection of dumpsites to receive the material. These dumpsites had to have either a solid bedrock or a deep clay underburden and preferably be on crown land. When this latter requirement proved impossible financial arrangements were made with the owners of the property.

Our main concern was that if the dumpsite was imperfectly chosen oil would leach down into the groundwater and contaminate wells over a wide area. To guard against this we arranged, with the co-operation of the provincial government, for five independent assessments, plus our own engineering assessment, of a chosen site after it had been opened up. Only when each of these assessments was positive was a site used.

The public were kept informed. On one occasion, although the dumpsite met all our requirements, the inhabitants in the area were opposed to a dumpsite anywhere near their homes and after public meetings failed to resolve the problem an alternative site was located.

Sites meeting our requirements were not easy to find. They involved a lot of field work on the part of our own staff and the staff of the provincial government, particularly the Department of Lands and Forests who were most co-operative.

When a dumpsite had been chosen it was excavated down to a reasonable depth, and when filled with soiled material it was covered over with clay, then with soil, and finally grass and trees were planted on it. In one location a municipal dump was used because it had satisfactory characteristics and there the soiled material was covered as soon as it had been placed.

We stress the urgency of research and development leading to a satisfactory way of disposing of the oil on the beach material and slick-licker debris by combustion. We have subsequently become aware of two or three Canadian companies with expertise in this field that might lead to a solution, but we stress the urgency of giving this development high priority. As far as we know, the capability of handling this problem is no better today than it was in the summer of 1970 and this we regret. The solution we used was very definitely second best and should not be repeated.

We also recommend that the dumpsites should be re-visited in about five years' time in order to determine the extent of biodegradation which has taken place over that period.

Debunkering

As reported in Volume I, we had ascertained that there was a sufficient amount of oil remaining in the stern section of the Arrow after the original debunkering to make a re-pump desirable and that this should be done in September when the water temperature would have risen above the pour point of the Bunker C. It was also reported that Lieutenant-Commander D.B. Hope would be assigned as salvage master for this operation and that his deputy would be Michael S. Greenham, Master Mariner, Ministry of Transport.

This operation was identified by the code name "Operation Scour" and was planned and executed with distinction by Lieutenant-Commander Hope and Mr. Greenham, as before with full co-operation from the Department of National Defence. The Navy diving team again did a magnificent job. The recovery vessel was the S.T. Imperial Cornwall chartered from Imperial Oil. The operation was "on schedule" throughout.

In the course of the operation Lieutenant-Commander Hope and Mr. Greenham improved in many ways on the innovative technology that had been developed under Captain Madsen's guiding hand on the first occasion and proved to our satisfaction that the technology for this operation is now in a mature form. It can certainly be improved but it is available to anyone in the world with a serious intent of recovering oil from a sunken vessel.

The detail of the story is best told in the language in which it was reported to the Task Force and this is presented as Appendix D.

A total of approximately 100,000 gallons was recovered in "Operation Scour".

By the spring of 1971 the bow section of the wreck had completely disappeared, having been broken up and driven off the top of Cerberus Rock into deep water by the severe winter storms.

There were one or two "scare reports" that the stern section had started leaking again over the next several months following Operation Scour. These were checked out on each occasion and the reports were not sustained by actual on-site observation. On at least one occasion we have reason to believe that the oil that was observed had come off one of the heavily contaminated beaches and moved around the coast as a result of a fairly vicious storm. These mechanisms were understood and were expected.

During the summer of 1971, fairly frequent inspections were made of the degree of leaching from the stern section.

On a day with any wind at all to ruffle the surface of the seas no sign of any iridescence can be seen. However, if there have been several hours of calm weather, a small amount of iridescence collects on the surface above the wreck and will travel about half a mile downstream in an iridescent patch about 3/10,000 of an inch thick and 10 yards wide. The amount of oil in this iridescence is inconsequential and has proven to be no impediment to any boating or fishing activity in the area.

To the best of our knowledge the hull is as clean as it can be made by mechanical methods and the iridescence that is slowly leaching off is due to oil still clinging to the outside of the hull and oil that is trapped between the beams and ceiling in the cabin area and under the deck strengtheners at the top of the tanks.

As it is no longer of any recreation or economic importance we believe the problem of the stern section has been resolved and no action to demolish it or remove it should be contemplated. However, *we recommend that when Ministry of Transport helicopters are in the area for any purpose and the weather is calm they should observe and report on the amount of iridescence,* if any, because we think it will be of advantage for future contingency planning to know how long a wreck lying in this depth and temperature of water takes to clean itself by normal water movement. There was no iridescence on 2 May 1972 in the vicinity of the wreck.

Canso Tickle Dam

The inspection of the Canso Tickle on the 24th of March 1971 showed that while there was still a substantial amount of oil in the small coves and on the rocks to the north of the Canso Tickle Dam, it appeared to have stabilized to the consistency of soft asphalt by picking up some of the fine silts and clay particles that comprise most of the fines in the beach material in this area. While we had nothing but our own judgement to go on it appeared that this stabilization had proceeded beyond the point where the normal rise in temperature during the summer months would again put the oil back in circulation. On the other hand, the continued presence of that dam was a considerable inconvenience to the fishermen who had their boats south of the dam as it forced them to go around Durrels Island to get into the Bay. This cost them both time and money and on occasion exposed them to unnecessarily rough weather.

Accordingly a decision was made to remove the dam before the opening of the 1971 lobster season and the work was undertaken by the Department of Public Works and supervised by their engineer, John D. Haikings. A local contractor did a good job. Water depths were returned to their original level and the area cleaned up so well that one could not tell that the dam had ever been there.

Lennox Passage Dam

This dam had suffered fairly severe erosion during the winter storms and it was necessary to build it back up in the spring of 1971 to make sure that it would last through the season. This project was commenced on May 12th and completed on May 17th, 1971, and involved the placing of an additional 7,064 cubic yards of material at a cost of just under $13,000. As before the borrow pit used for this additional fill was leveled and contoured when the job was finished so there was no environmental degradation.

Because of the slick-licking operation in Inhabitants Basin and the small amount of oil that was still moving around in the west end of Lennox Passage a decision was made to leave the dam in place during the summer months and inspect it again in the autumn. This latter inspection was carried out on the 18th of September. The situation was greatly improved but there was a shoreline about three miles long on which there was still some unconsolidated active oil. This oil moved only a few inches on any one tide but there was the possibility that when ice formed during the winter it would be picked up by the ice and get back into circulation when the ice melted. If the dam was removed and the ice went out to the east this oil would constitute a minor pollution risk for beaches in the Louisdale-St. Peter's area which had remained unpolluted owing to the presence of the dam. Accordingly the decision was made to leave the dam in during the winter. The area was inspected in May 1972. The oil was found to have stabilized sufficiently and the removal of the dam will be commenced in June of 1972. Thus navigation will be restored prior to the onset of the 1972 tourist season.

The plan approved by the Navigable Waters experts is that we will remove a 250-ft. section of the dam centred opposite the swing section of the bridge. This will involve the removal of some 20,000 cubic yards of fill and is estimated to cost $35,000.

PART 4 – COSTS

As the costs included in Volume I of our report were only up to the 15th of July 1970, with estimates to the 30th of September, it is considered appropriate to include a complete recapitulation of the costs of this operation.

There are three ways of looking at these costs. One is to include only those costs that are external to the government's own forces. The second is to include only those costs that are over and above the normal budgetary provisions of the government. For example, the Navy divers were going to be paid anyway, so their salaries should not be included. The third is to treat the entire operation as a business proposition (excluding profit and the second generation overhead which cannot be identified in government and university accounting systems).

We have chosen the third method because the choice as to whether to use government forces or private sector forces was on us, and another Task Force on another occasion might make different decisions. The figures which follow were given to us to the nearest cent. We have arbitrarily rounded them off and anyone using them should add the second generation overhead mark up of their own choice.

Unless there is some entirely unforeseen contingency the only cost remaining will be the removal of the Lennox Passage Dam and a final cleaning of Black Duck Cove, for a total of under $45,000, and this has been included.

Summary of Costs

Operation Oil – re Grounding of S.T. Arrow, 4 February 1970

I	Ministry of Transport and Task Force -Removal of oil from wreck		608,000
II	Ministry of Transport and Task Force - Protection of Fisheries and Property		94,000
III	Ministry of Transport and Task Force - Clean-up and Containment		863,000
IV	Ministry of Transport and Task Force - General Support Costs		
	a) Not allocated to specific activities	621,000	
	b) Payment to DND	384,000	
	c) Payment to AOL	295,000	
	d) Payment to Fisheries and Forestry (now part of DOE)	13,000	
		1,313,000	1,313,000
V	Department of National Defence	1.147.000	
	Less payment by MOT	384,000	
		763,000	763,000
VI	Atlantic Oceanographic Laboratory	295.000	
	Less Payment by MOT	295,000	
		0	0
VII	Fisheries and Forestry (now DOE)	105,000	
	Less payment by MOT	13,000	
		92,000	92,000
VIII	Fisheries Research Board of Canada		
IX	Canada Centre for Inland Waters		5,000
X	Canada Wildlife Service (not costed		86,000
	separately from regular operations)		0
XI	Government of Nova Scotia		14,000
XII	Estimated cost of removal of Lennox		
	Passage dam and Black Duck Cove clean-up		45,000
			3,883,000

PART 5 – PAST AND PRESENT

At the time of presenting the first three volumes of our report many of the operations were still under way and we had not yet participated in the marine inquiry. There are therefore a number of matters on which we wish to report at this time, some of which were in operation prior to August 1970.

Endemic Problems

We encountered some problems which appear to us to be endemic.

1) Ships clearing port seem very impatient to clean their bilges and tanks by dumping the slop of oil and water into the ocean. This is a disgusting habit and completely inexcusable when one realizes that facilities into which this mess could be pumped are available at almost all ports in Canada and should be extended to cover the remainder. This callous practice caused us extra work because at least three ships outbound through Chedabucto Bay at night pumped tanks and/or bilge during the summer, leading to the re-fouling of beaches and extra clean-up costs. The Masters of these ships obviously considered that with all the Arrow's oil around they could do this with impunity.

   We suggest this kind of nonsense, which we believe is widespread, has to stop. Why not require ships to pump bilge into shore tanks before they are given clearance to leave port? This would stop some of it by making the practice unnecessary.

2) There appear to be no regulations regarding the location or dyking of shore tanks holding petroleum products. A tank farm of the Irving Oil Company at Canso is located right at the water's edge with no surrounding dykes. Our clean-up of that harbour was prolonged and made more costly by a persistent slow leakage of oil from the shore into the waters of the harbour. Whether it was the result of current or previous leaks from this tank farm remains in doubt.

3) There appears to be a time honoured practice on the East Coast of Canada and elsewhere that it is fair game for private, or commercial divers to descend onto wrecks and take anything they wish and can. These scavengers, or pirates – the names are used interchangeably – make some money by removing brass fittings and the like for which there is a ready sale in the junk market. In spite of repeated public warnings by press, radio and television that Operation Oil was still working on the wreck and that it was not abandoned and therefore should not be scavenged, the stern section of the Arrow was visited, at night, at least three times by pirates. On one occasion they succeeded in removing the propellor by the use of explosives but were unable to lift it. (This propellor and the spare propellor in the bow section were subsequently recovered by the Task Force and taken to Dartmouth). On another occasion, whether by accident while using explosives to loosen a piece of brass, or by design, one of the tank top parts was opened and a quantity of oil escaped. (This was in August, prior to Operation Scour). Some beaches were recontaminated. For a period we had either a Coast Guard, Fisheries, or RCMP boat on police duty at the wreck site in an attempt to demonstrate to the pirates that we meant business. The situation is rather like the rum-running into the U.S. during the prohibition era – you knew who they were but could not catch them at it.

4) Finally, during the period from April 11th when the original debunkering operation was completed and September when Operation Scour was completed, there was a continual struggle to keep the leaching of oil from the wreck to an acceptable minimum. Most of this arose primarily because of the disgraceful condition of the Arrow before she sank. The gaskets on the tank tops and parts were largely perished or non-existent. The venting pipes for the oil tanks (these pipes were on the deck) were in an advanced state of corrosion so that when the Navy divers attempted to drive plugs into the broken ends of these pipes they tore or split. The plugs could not therefore be driven home firmly and had to be wired in loosely. The engine room, and all the cabins and working space on the ship as well as the hull itself, had been filled with Bunker C as the ship sank in the middle of her own slick. As the water temperature rose this oil started to flow off the wreck and rise to the surface.

   The Navy divers made several descents onto the wreck during the summer to re-seal the tanks and pipes or to tighten things up after a visit by the pirates. In this way the leaching of oil was kept to a minimum but was still very visible. After Operation Scour and throughout 1971 the leaching was insignificant and only visible on a completely calm day.

Operation of Net Laundry for Oil Contaminated Fishing Gear

The plans for the fishing gear laundromat were presented in Volume III and a brief reference to its operations is contained in Volume I. We now have pleasure in including as Appendix E a report on the operation of this net laundry prepared by the man who made it work, Mr. J.B. Myrick of the Fisheries Service of what is now the Department of the Environment.

We would like to stress that this particular aspect of our operation showed the importance of close co-operation between the scientists, industry and those with operating skills. The members of the scientific team co-ordinated by Dr. Ford produced the design of this laundromat within 72 hours and it was manufactured and installed within three weeks following our original request. Arrangements were made to have it installed in the compound of Nova Scotia Power at Point Tupper as in this way we would be able to get a good supply of steam and hot water. The crew under Mr. Myrick gained operating experience very quickly and when the job was finally completed in the autumn they had cleaned something in excess of $150,000 worth of gear with no failures for a capital investment of some $20,000. Considering that we would have otherwise had to compensate the fisherman not only the $150,000 but the awkward assessment of the value of lost fishing time, this is not a bad investment and not a bad contribution by science, industry and operating expertise.

This gear ranged all the way from a large purse seine net valued at $25,000, of which there were several, to gate valves and other equipment used in oil recovery operations prior to putting these in contingency stores.

There is no doubt in our mind that a laundromat of this sort will be required in any large scale clean-up operation in an area where fishing is taking place. The equipment which we had manufactured could be redesigned with advantage. We think the external dimensions of the high pressure steam and high pressure water cylinders were unnecessarily large and the mechanical agitation of the degreaser mixture could be improved. Also, there should be the opportunity of going back over the chemistry of the problem to see whether the choices of our scientists were optimum or not. Because of the speed with which they came up with the design it is altogether likely that while they were close to dead centre they were not optimum, and a modest expenditure on further development right now would bring the gear to an advanced stage where additional units could be manufactured on short notice if the need arose. But we must remark, as we pass the second anniversary of the grounding of the Arrow, that the work is not yet under way.

Co-operation

In these days when it seems to be a favorite pastime of Canadians to point out the antagonisms between municipal, provincial and federal governments and their servants and the supposed soliditudes between industry, universities and government, be it in operations or in science, it is a pleasure to be able to report that on the basis of our experience on Operation Oil, when the chips are down these differences seem to become inconsequential. Throughout the entire operation we have enjoyed wholehearted co-operation from the most senior to the most junior ranks in the government of the Province of Nova Scotia and particularly from their Department of Lands and Forests and the provincial Emergency Measures Organization. We have received tremendous co-operation from the Department of National Defence and the Department of Public Works. The field staff and field scientists of the Department of Fisheries (now the Fisheries Service of the Department of the Environment) and the Fisheries Research Board have also made magnificent and timely contributions.

The co-operation from the scientific community in university, industry and government laboratories was outstanding, and it is to our regret that we must record that much good research that is needed to improve Canada's capability to deal more effectively with subsequent pollution disasters of this sort remains unfunded and the scientists frustrated. While the appointment of two experienced operations officers within the Ministry of Transport to deal with oil pollution has been a tremendous step forward, they still lack the scientific support needed to make proper assessments of both equipment and plans. Co-operation must be strengthened between the Department of the Environment and the Ministry of Transport if the Department of the Environment is to fund those things which are of importance to the Ministry of Transport's operational responsibilities.

As oil pollution is a world-wide disaster we suggest that if proper choices are made and very modest funds are put behind commercial enterprises to push devices to the operational stage, there is every possibility that we can capitalize on our Chedabucto Bay experience and develop products and devices that will be of use and value to the world. It is suggested, however, that before this will be accepted internationally these products must be ordered by the Canadian Government and placed in its contingency packages. This confidence in our knowledge and abilities will not only further our own readiness but will be of great value to Canadian developers and manufacturers by fostering sales abroad.

Marine Inquiry

The inquiry into the grounding of the Arrow and the subsequent major oil pollution of Chedabucto Bay, some adjoining areas and Sable Island, seemed to us to exhibit constraints of a judicial character which effectively prevented the obtaining of answers to many questions which we consider important if the frequency of this type of accident is to be reduced.

Why, for example, was so much of the navigational equipment unserviceable? Was it faulty design, faulty manufacture, faulty maintenance, or improper use?

What was the real level of competence of the ship's officers? What training had they received? When had they received it, and how?

We have given much thought to how this situation might be improved. The technical, engineering, scientific and operational aspects of transportation accidents seem to us to have much in common regardless of the mode of transportation involved (land, sea or air). It seems to us that there should be a highly competent group of operations specialists, engineers and scientists who would carry out an immediate investigation of all serious accidents for which the Ministry of Transport has the investigative responsibility. This investigation should be pressed to a logical conclusion before any judicial inquiry is initiated. This expert investigation team should take full acount of all aspects of the accident and will need to act with a substantial degree of independence. We would argue that such a procedure, far from usurping the prerogatives of the judiciary, would make their job more meaningful by providing a better base from which the legal considerations could be initiated.

We recommend that new practices and procedures be developed to be used in the investigation of marine accidents to ensure a full technical, engineering, scientific and operational diagnosis of an accident, complete with recommendations on how to prevent similar accidents in the future, and that these investigations be carried out prior to the judicial inquiry.

Marine Regulations

We were delighted by the passage of Bill C-2 and we have been eagerly awaiting the proclamation of the Regulations to give the new Act some teeth and some operational muscle to deal with the problems. We have quite naturally not been consulted in the drafting of these Regulations but our opinion has been informally sought on two or three occasions and we have developed a disquiet that the Regulations are being written in such a way as to emasculate Bill C-2 and frustrate the intent of Parliament. In the meantime minor spills go on and on and yet another tanker came into Canadian waters with radar trouble and no large scale coastal charts at all. Fortunately this one had the good sense to drop anchor and wait until a coastal chart had been taken out by the Canadian Coast Guard, but can one imagine an Air Canada airline pilot arriving over England and declaring a state of emergency because he did not have a landing chart for London Airport?

We must also draw attention to the recent grounding of the SS Vanlene off Barkley Sound on Vancouver Island. This is a classic repetition of the Arrow – substandard certificates of competency, virtually no navigational aids, and a Captain who was something in the order of 40 miles north of his estimated position. Not only did he hit the wrong piece of shore, he was even in the wrong country. Fortunately the cargo was not oil. Surely this is an ugly warning of what will happen if a major tanker route is developed from Valdez to Cherry Point.

We are delighted at the action taken to establish positive approach control for the supertankers coming into the new oil refinery at Point Tupper, but that refinery has already had its first spill, fortunately a minor one.

Positive en route and approach control of all merchant ships should become a world standard without delay.

We sincerely hope that the implementation of Bill C-2 and other corrective actions will be pushed vigorously, not only domestically but internationally. At the present time the slovenliness of some of those who sail merchant ships, and tankers in particular, is only exceeded by the tolerance of the public, which we hope is wearing a bit thin. There is evidence that the biological ability of the oceans to cope with this pollution is reaching its limit, adding a further note of urgency.

VOLUME IV

APPENDIX A

BEACH RESTORATION REPORT

by

John W. MacKay

December 1970

Activities during 1970
following the grounding of
the tanker Arrow in Chedabucto
Bay 4th February 1970

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INTRODUCTION

After the grounding of the tanker "Arrow" and subsequent spillage of oil into the waters of Chedabucto Bay, approximately 190 miles of coastline were subjected to varying degrees of oil pollution.

During the initial stages, oil was removed experimentally from a few beaches by the Army.

On April 24, 1970, a crew of labourers ("slick pickers") were organized by the Department of Public Works of Canada to shovel the oiled material off the lightly oiled beaches into plastic bags in the Bay of Rocks area. Machinery commenced work on the heavily oiled shoreline of Arichat and Black Duck Cove on April 30.

This report deals with the beach cleaning directed by the Department of Public Works and attempts to give a description of the clean-up program. Seventy-eight beaches totalling approximately 30 miles of shoreline have been worked to date. Some areas have since been re-cleaned.

Part I is a generalized review of the program plus our observations and experiences. It may provide some guidance in the event of future spills.

Part II discusses 43 areas which are significant with respect to the beach type, the technique used, or the problems encountered. A detailed time, cost and equipment breakdown is given for each area.

The restoration program commenced in May 1970 and ended the first week of November. Requests and work began to taper off in the September and October period. The beach restoration program aimed to clean oil contamination from the "nationally rated" beaches (this designation was provided by the Government of Nova Scotia and its Department of Lands and Forests) and the "community" beaches. The latter definition was interpreted very flexibly but generally used to classify a recreation area used by a number of people or some section of shoreline used for fishing purposes. The fishing areas received priority over recreation and the number of users was not considered. Wherever possible with the methods at our disposal an area used by fishermen was cleaned.

The selection of community beaches resulted solely from requests generated by the residents. Unfortunately, not all requests could be acted upon. The reasons for this will be discussed later. At no time was a clean-up of the entire shoreline ever attempted. Approximately 190 miles of shoreline were polluted (see chart, Appendix 1); about 30 miles were cleaned, some of which were recontaminated.

The following is a list of the areas worked (see chart, Appendix 2), plus a brief description of what was done:

Arichat Contract: Discussed in Part II. Recontamination in some sections by autumn storm action.

Babins Cove: 800 feet of the Babins Cove, Bosdets Point Contract cleaned twice by contractor. Small amounts of recontamination observed continually during the summer. Pickers were employed in late July but work was terminated after heavy oiling during time of the unauthorized opening of the wreck. No further work was carried out in this area as recontamination continued, possibly coming from the adjacent rocky shoreline, Jerseyman Island or beds of eel grass between this Island and the beach. Future machinery clean-up not recommended as sediment supply is limited. Used extensively for recreation and also for a boat haul-up.

Black Duck Cove: Discussed in detail on page 46, Part II. Autumn storms have resulted in waves spraying oil over beach front road. A footpath was improved to make a usable access for one resident.

L.C. Boudreau: Adjacent to Cape Auget breakwater – cleaned by pickers.

Boudreauville: Usually referred to as the Point Beach; 280 feet cleaned under the Miscellaneous Beach Contract (Isle Madame areas); 340 feet cleaned by pickers. Recreation area.

Boudreauville: (Adjacent to the breakwater.) 400 feet cleaned by pickers. Fishing and recreation.

Burkey's Cove: 320 feet cleaned by pickers. Fishing and recreation.

Bosdet Point: This beach (850 feet), together with Babins Cove was to have been cleaned under contract. However, it proved impossible when the bearing capacity of the beach was not sufficient to support machinery. Contamination was too extensive to be feasibly cleaned by manual methods. Recreation area.

Cape Argos: Cleaned by pickers

Cape Auget: Both sides of wharf for a lineal footage of 560 feet cleaned under Miscellaneous Beaches (Isle Madame) Contract. Isle Madame fishing area.

Cape Auget (Gerald Marchand): Manual and machinery. Fishing and recreation. Some re-oiling in late August necessitated a second picking.

Cape Auget (Clifford Boucher): Area of proposed recreation development by Mr. Boucher. Requested to clean approximately one mile but with the stipulation that we not remove any material. Bulldozer pushed oiled material up to backshore for a frontage of approximately 2,000 feet. Operation discontinued because of re-oiling of cleaned section, and because it was felt that the length requested was somewhat beyond the terms of reference of this program.

Chapel Cove: Approximately 1,500 feet cleaned by pickers. This area has remained clean.

Canso (Breakwater Beach): See page 59; Part II.

Canso Tickle: A dam constructed below the bridge to Durell Island prevented contamination of the eastern section but both shores on the western side remain extensively oiled. As the movement of water is minimal and the depth of oil is considerable, the natural clean-up and stabilization in this area was far less than other parts of the Bay. In late October, the oil on the rocks was still fluid and iridescence was present on the water surface. During the summer, pools of oil were shovelled into plastic bags and removed. In late August, a decrease of the oil-on-water was thought to have occurred. One small beach (Lumsden's) was selected for clean-up. This was a 50 foot shingle beach bounded by boulders and was used to indicate whether effective clean-up could be accomplished. After all oil which could be removed was taken away, limestone was applied, then one foot of clean material was placed over the area. Unfortunately, recontamination continued until the appearance of this area was indistinguishable from the remainder of the western side of the Tickle.

The terrain of the Tickle consists mainly of boulders and rock cliffs interspersed with small pocket beaches to which vehicle access is largely limited. If the recontamination problem had not existed, the amount of clean-up possible would have been very small. To date, we have no non-chemical methods capable of cleaning rock and boulders or of effectively stabilizing the movement of oil off them.

Canso (adjacent to Government Wharf): 50 foot area cleaned by pickers; experienced periodic light re-oiling from an onshore source close to the fish plant wharf.

Cove Road (W. Arichat): Attempted machine clean-up but not effective. Most of the area consists of a heavily oiled clay beach with the water close to the surface, hence restricting vehicle movement.

David's (Areil), Arichat: Worked by pickers, material removed by D.O.T. barge. Remained clean. Recreation.

Deep Cove: page 74, Part II

DeYong's Sand Bar: Pickers, removal by barge. Boat haul-up and recreation. Clean.

Eddy Point: See Sand Point, page 57, Part II.

England (Preston): Community of Sand Point. Machinery, 225 feet, Recreation. Remained clean.

Evanston: See Inhabitants River Area, page 68, Part II.

Fox Island Main: Also called Indian Cove, Part II, page 50. This beach re-oiled in early October. Further discussion on this matter is contained in the recontamination section.

No action was taken on the coastline of the Island.

Fox Island – Other Beaches: Two main areas cleaned by machinery behind the summer cottage area. Some material replaced. In another section, clean material was deposited over the contamination. This area has remained clean.

Glasgow Head: Situated close to Canso Marine Radio. Sand beach located on one side of an open lagoon, used for swimming instruction and other recreation. Despite heavy oiling, this area could be worked by pickers as the contamination had mixed with the sand, dried, and was beginning to flake off. Removal was difficult due to the terrain. A dozer and float was finally used at a cost of $4,766.00. This area is clean at time of writing.

Godie Point: See page 66, Part II

Gracieville: See page 66, Part II

Grand Grave: See page 66, Part II

Grand River: See page 66, Part II

Hadleyville: See page 52, Part II (Hadleyville #1)

Hadleyville #2: See page 52, Part II

Half Island Cove: See page 52, Part II

Halfpenny Pond: The pond itself was impossible to clean except for debris. A brush boom was placed where the pond passed under a highway bridge to prevent contamination of shoreline adjacent to where the pond emptied into the Bay. Machinery cleaned this section of shoreline which was used by fishermen. It has remained clean.

Halfpenny (Douglas): Recreation area – material pushed up by dozer against backshore cliff. Clean.

Halfway Cove: Clean.

Irish Point: West Arichat (adjacent to RCMP). 150 feet cleaned by pickers. Experienced periods of slight re-oiling and natural cleaning during summer but was usable.

Inhabitants River Beaches: See page 68, Part II

Inhabitants River Bridge: Adjacent beach cleaned by machinery – used for recreation. Remained clean.

Janvrin Harbour Wharf Area: See page 55 , Part II. Remained clean.

Janvrin Harbour South: Pickers. Recreation. Clean.

Janvrin Harbour (D.M. McNeil): Attempted cleaning after Janvrin Wharf area cleaned, but beach too soft to support machinery. Cleaned by machinery in September but as material could not be removed it was deposited at the base of a cliff. No re-oiling.

Janvrin Harbour (Gunnar Peterson's): Requested to clean the above as a recreational area for local residents and summer cottage owners, one of which was Mr. Peterson, who, residents state, owned the frontage property. Later, Mr. Peterson stated he was not the present owner and requested two other areas. One, adjacent to side area, was impossible to clean, the other by Janvrin Island disposal area was being contaminated by oil floating off Rabbit Island. This latter area was cleaned by pickers, the material removed by privately owned barge, and the area remained clean.

Landry's Cabin: (three miles from Mulgrave) Cleaned one-half requested area by pickers. Remainder was unworkable as it contained bedrock.

L'Ardoise Area (Rockdale): See page 66 , Part II.

Martin Point: 3, 000 feet cleaned by pickers. Also called Lower L'Ardoise; discussed in Part II, page 66.

MacDonald's Beach: Nationally rated but access owned by Floyd MacDonald who stipulated that no machinery be used during cleaning. Pickers cleaned approximately one-third of the length before contamination became too heavy for manual methods. Work was discontinued; the cleaned section was re-oiled.

MacDonald's (Janvrin Island West): Material removed from the beach by machinery and stockpiled along the backshore. Unable to haul material from site.

Martinique Park: Pickers cleaned a small area, no re-oiling.

Martinique: Pickers cleaned a recreation area on property owned by Edna Rowe. No recontamination.

Melford School and Melford Church: Areas used for recreation by the groups implied in their names. The first was worked by both pickers and machinery, the second by machinery. Small amounts of recontamination were observed after the unauthorized opening of the wreck, but this was removed by wave action.

Moose Bay: Also called Clam Harbour or Port Shoreham. Discussed in Part II, page 70. Clam Pond and Ragged Head, bodies of water behind this beach, contained oil around their perimeter and below the water level. They could not be cleaned by the methods available.

Petit de Grat areas: Discussed in Part II, page 73 , they include:

1. Adjacent to Boudreau's Fish Plant
2. Gros Nez
3. Louisiana Chicken Coop
4. Petit de Grat Bridge
5. Petit de Grat Point
6. Sampson's Beach

Philips Harbour: See page 61 , Part II.

Point Michaud: See page 66 , Part II.

Pondville & Pondville South: — or Little Barachois. See page 49 , Part II.

Port Richmond: See page 68 , Part II.

Port Malcolm: See page 68 , Part II.

Queensport (East of bridge): See page 59 , Part II.

Queensport (West of bridge): Cleaned by pickers, as in previous case. Beach remained clean after installation of brush boom.

Rockdale: Discussed under L'Ardoise areas in Part II.

Rocky Bay and Rocky Bay North: See page 49, Part II.

Sampson (Eric) (W. Arichat): 320 feet cleaned under the Miscellaneous Beaches (Isle Madame) Contract. Another section cleaned by pickers. This area experienced heavy re-oiling during the pirates' visit to the wreck. Re-cleaning was not considered as this area is subject to erosion.

Sand Point (Lighthouse): See page 57 , Part II.

Sand Point (Breakwater): Recreation and fishing area, cleaned by machinery. No re-oiling.

Sam Scott's: 200 feet; used extensively for recreation and fishing. Cleaned by pickers but re-oiled during the unauthorized opening of the wreck. Re-cleaned by machinery depositing the contaminated material against the backshore at the owner's request.

Seacoal Bay: See page 68 , Part II.

St. Esprit: See page 66 , Part II.

St. Francis Harbour: 2,200 feet was cleaned under contract, some of which was replaced. Also included in this contract was 2,200 feet in an adjacent area called Diggin's Beach. The first area was used for fishing, the second for recreation. Both sections remained clean.

Steep Cove: Recreational area. Cleaned by pickers.

Walkerville: See page 68 , Part II.

Whiteside: See page 68, Part II.

Unfortunately, we were unable to act on all requests received. The members of the beach restoration organization, being in daily contact with the residents of the area and the field staff being themselves residents, were well aware of the difficulties and frustration created by the pollution. Despite our regrets, we were limited by the capability of the methods at our disposal.

The most prominent reason for not acting on requests was inaccessibility of the site. This occurred on a few occasions where the users had always walked down the cliff to the beach. Another reason was the observed continuance of recontamination. Such clean-up would have been futile and was not attempted unless some possibility existed that its effects could be lessened or the oiling would be minimal. It was not until the latter part of the program that such a judgement could be made.

A few requests were considered unreasonable.

ORGANIZATION AND PROCEDURE

After the Department of Public Works' Engineers had completed construction of the Lennox Passage and Canso Tickle dams, a resident engineer was placed in Port Hawkesbury for the beach restoration program. After inspecting the majority of the contaminated areas, an office was established at Operation Oil Headquarters in the Port Hawkesbury Motel. Eventually, three university students were selected as project co-ordinators, each with an assigned territory and working out of the office. Unfortunately, no experienced construction supervisors were available at the time. The helicopter was an invaluable asset in the initial stages as it allowed the engineer to inspect all sites at least once per day while the co-ordinators were gaining experience. All three plus the office clerk did an excellent job, working up to 16 hours per day.

All important jobs had an on-site fieldman, who under the direction of the co-ordinators supervised the labourers or contractors, recorded the hours worked and the amount of material removed. This was usually a local resident.

The uncertainty of mail delivery during this clean-up forced us to revise our tendering procedure. The revised procedure permitted us to survey a beach one day, write the conditions of the contract that night, phone all prospective bidders giving the details the next morning, and have the document picked up or delivered the same day. Depending on our schedule, but on a few occasions, tender closing was within three days (usually a weekend). The bids were telexed or telegraphed to the District Department of Public Works Office.

This method expedited the work tremendously and is recommended for any future programs where clean-up must proceed as rapidly as possible.

Rental of equipment by the hour rather than contracting was used where:

1. the total estimated value of the work was under $1,000.00,

2. such equipment was required immediately,

3. delays such as removal and replacement of skidways and fishing equipment would be encountered,

4. involved and intricate instruction coupled with extensive supervision were required and could not realistically be written into contract documents.

Further discussions on this matter are contained in the Methods of Clean-up section.

DISPOSAL OF CONTAMINATED MATERIAL

The disposal areas were selected by the Task Force Operation Oil with the help of the Nova Scotia Department of Lands and Forests but were only approved for use after a thorough inspection by five separate Provincial Agencies, all of whom agreed that the site met the rigid specifications that had been laid down by the Task Force.

Cape Auget (inaccessible and unusable)
Dover Municipal Dump
Doyle Road
Fox Island
MacIntyre Lake (not used)
Port Royal
Sand Point

The construction of these sites was supervised by the Department of Public Works. The construction consisted of bulldozing to a depth of 4-6 feet, staying within the claysand loam and banking the sides with this material. At Sand Point, bedrock was encountered, and it was stipulated that a layer of clay be placed over the bottom. On one occasion, water had to be drained from the dumpsite by making an opening, constructing a fir bow filled trench to filter the oil from the water, then closing the opening.

Cape Auget site was not used during the D.P.W. clean-up but was covered, seeded with grass and trees planted during this time.

Other disposal areas covered with topsoil were: Doyle Road, Fox Island, Port Royal, and Sand Point. Trees have been planted at Port Royal and Doyle Road.

On evaluating our summer experience, we feel that less elaborate precautions would be sufficient. This is based on the observation that the usual depth of oil penetration in clay was 4 inches, in sand 6 inches. Also, the oil was mixed with beach material. If the disposal area is covered and sloped to facilitate runoff and streams of water are not present, it does not seem possible that the oil will reach the water table. Heavily contaminated beaches and backshore stockpiles of oiled material existed throughout the program within 100 to 1000 feet of drinking water sources at Walkerville and Janvrin Harbour (McNeils). These areas were worked with great difficulty. The bearing capacity of the beach material was low due to the proximity of the water table.

Precautions should be taken, but in numerous areas removal was difficult and costly while unused backshore areas existed. Placement of such materials in the backshore should not substantially increase the danger of water contamination over that of having it on the beach.

COST OF RESTORATION PROGRAM

The total cost of the beach restoration program undertaken by the Department of Public Works in 1970 was $375,000.

METHODS OF CLEAN-UP

The methods of beach cleaning in Chedabucto Bay might be classified into two main categories:

(a) Labourers
(b) Machinery

(a) *Clean-up Using Labourers*

The men who removed the oiled material off the beaches were referred to throughout the operation as "slick pickers" or "pickers". Their modus operandi consisted of:

1. using hoes, rakes or forks to gather material into piles. This was done only where required – the rakes and forks to pick up small accumulations of seaweed, the hoes to scrape off a thin layer of contaminated sediment.

2. shovelling this material into plastic bags. The type of bag used was 0.006 mil, 18" X 25", plain polyethelene, with a brand name of Milpack. They were manufactured by CIL and cost approximately 13¢ each, delivered. They were found to be satisfactory and could be used three times if material was not so oily as to stick the empty bags together and did not remain on the beach long enough to harden in the bags. The last factor made it impossible to re-use bags used in areas where the material had to be hauled out by barges. Larger bags tended to break when being loaded.

   On a number of occasions, the material was shovelled directly into trucks. This was found not to be as productive, and did not permit optimum use of the truck.

3. *Removal from Beach.* A variety of vehicles were used for this purpose. For the small volume operations, a 4-wheel drive, 3/4 – 1 ton capacity truck was used. This vehicle drove onto the beach and was loaded with the bags. It was also used in high volume removal operations where the haul road was inaccessible to ordinary trucks. This applies mainly to early season clean-up when the beach roads were still soft and wet. The rate paid for this type of vehicle was from $6.00 to $9.00 per hour (including driver), depending on the lowest price that could be negotiated. Prices paid for all equipment was based on the Nova Scotia Road Builders Association schedule for equipment rental. When not listed in this schedule, the rate was calculated using the Nova Scotia Department of Highways formula:

Basic Monthly Rental = Replacement value x 9% = $x

Running Repairs = Replacement value x 2% = $y

Monthly non-operating rate = $ (x + y)

Hourly Rate $= \frac{x + y}{225} =$ z

Operating Rate = $z + operating expenses adjusted to round figures.

In large scale removal, it was more economical to use a two-stage operation. One vehicle moved material to a loading area, then 18,000 lb. capacity dump trucks would haul to the dump site. For moving the material to the loading area, 4-wheel drive trucks, farm tractors, labourers with stretchers, front-end loaders, small dozers hauling a float, and tree farmers (see page 67) were all used. The type of vehicle used depended on their availability and the particular circumstances in each area. When the beach has a uniform particle size, a 4-wheel drive truck and the tree farmer were best suited. Large trucks such as tandems were too difficult to load without machinery.

In two inaccessible areas — Janvrin Harbour (Gunnar Petersons) and Arichat (DeYong's sand bar), motorized barge transported the bags to a loading area. This was only possible where the shoreline would permit a barge to come in sufficiently close for loading. At Janvrin, the barge was equipped with wheels and an outboard motor, thus allowing it to be towed up the beach. When the current was heavy, the barge was towed with a boat.

(b) *Machinery*

As discussed in Part II, two basic machine type operations were used in this clean-up — (i) bulldozer — loader — trucks (ii) loader - trucks.

During the Arichat, Black Duck Cove and Fox Island Main clean-ups, (pages 43 — 51), the trial and error method brought forth some simple guidelines on machine usage. Repeated briefly, they were:

(1) keep machinery out of the water
(2) remove all disturbed material before the tide rises
(3) use a bulldozer only under specific circumstances
(4) use a loader in deep oil contamination
(5) clean or attempt to stabilize all potential re-oiling sources before working designated area.

Items (1) and (2) have been discussed throughout Part II. Generally, only the amount of contamination that the available, machinery can remove in one tidal cycle should be marked for that day's work. Work should proceed along the shore from the point of access and from high tide to low, staying approximately ten feet from the water at all times. Fortunately, the amount of contamination adjacent to low tide was usually small. Below low tide, it was usually confined to beds of seaweed.

Bulldozer-Loader-Trench Operation

Bulldozer (Item 3) usage in the initial stages of clean-up resulted in considerable mixing of clean and contaminated material, thus necessitating the removal of larger quantities than required. These were dozers of the 105 — 120 flywheel horsepower class and were found to be somewhat unmanageable. They did not have an adjustment which would permit the blade to be angled to the direction of travel. In numerous areas, the bearing capacity was not sufficient to support this heavy machine.

In addition to the limitations of the machine, the majority of operators are excavator oriented, that is, they tend to move large volumes of material without regard to the capability of loader and trucks.

Small dozers of the 65 H.P. (flywheel) class were found useful and efficient when used in specific ways.

One method used successfully was a dozer with a blade angled 45 degrees to the direction of travel. This was first used at Janvrin Harbour (part II, p.55) and performed well in uniform depth contamination of fine sediments. For best results, rows are constructed of two or less passes on each side and then removed by the loader. These rows can be either perpendicular or parallel to the water. The number of passes made by the dozer in forming the rows would naturally be limited by the depth of contamination, although our experiment indicated that for lateral movement greater than two blade widths, considerably more clean material would be removed. In coarse sand and gravel type areas, this procedure did work but not as well as on clay and fine sand beaches. In the latter, the material did not "peel off" so readily and move along the blade, but tends rather to pile up and flow in front of the dozer.

On the Inhabitants Bay and River shoreline dozers were used, with the operators' actions being closely supervised. This produced complaints from the contractors that we were interfering unduly in their work, but did result in satisfactory work. These objections from the contractors had been anticipated and consequently the specifications had been phrased to permit direction of the work by our staff.

The procedure used consisted of pushing the material up the beach to the edge of contamination and cleaning approximately 25 foot wide strips. A 65 H.P. dozer with no blade adjustment was used. The cleaning of narrow strips was beneficial in two ways:

1. It kept the amount of material on the blade to a minimum, thus lessening spillage along the sides.

2. It allowed the contractor to work with the tides.

In the Inhabitants River beaches, the dozer was used to push the contaminated material against the backshore cliff. Here it was impossible to remove the material. The width of beach varied but was usually 30 to 40 feet and the contamination was not deep. In other areas where these conditions existed, the material was left on the beach. On three beaches, the owners of the frontage property requested this to lessen wave action. In areas so worked, a small amount of clean material or limestone was placed over any fluid oil in an attempt at stabilization, thus lessening leaching and contamination by wave action.

Loader – Truck Operation

This combination of equipment was first used on Fox Island Main beach; the encouraging results led to its usage on all subsequent oil contamination greater than 1 foot deep. The loader was particularly useful in the "deep trench" type contamination that existed on the gravel beaches on the west side of Chedabucto Bay. To lessen spillage, it was essential that the operator not fill the basket to its heaped capacity. A large loader (4 c.y.) with rubber tires was found suitable on all beaches except in muddy sections. A tracked loader was also used with success.

In depths of 3 – 4 inches of contamination, the loader was found to remove a high percentage of clean material. Due to the thickness of the teeth on the bucket and the limited precision of operation, from 1" – 2" of excess material was taken in each filling.

Loader Vs. Loader and Dozer

Based on our experience, which combination to use depended on the depth and distribution of material. For a blanket of oil 2" – 6", a dozer was found to be most effective and efficient. When the depth of contamination exceeded this value, a loader alone was best suited.

Machinery Vs. Pickers

Actually, there is not a choice between these methods. The choice is dictated by the type of oiling. Picking is feasible where the contamination is in scattered spots and depths of less than 4 inches. Except where the rate of erosion is substantial, the removal of greater depths of contamination is neither economical nor effective (see Moose Bay, p.64). As pickers remove less volume of material, they were used in depths and distribution of oiling greater than above, because certain beaches did not have an ample supply of sediment replenishment, i.e. Queensport and some portions of Petit de Grat.

Effectiveness of Clean-up

For the majority of beaches with moderate to heavy oiling, it was found almost impossible to remove 100% of the contamination on the first attempt. Mainly this was due to two factors:

1. Isolated spots of oil which had been covered over with clean material at the time of work but were later revealed by sediment movement.

2. "Sediment Shield Effect" for want of a better term, used to describe the covering of oiled particles with clean sand or clay so they appeared non-contaminated, these fine sediments having been "stirred up" by pickers or machine action. This condition was found usually in heavy concentrations of semi-fluid oil. Following clean-up wave action washed off some of this adhering material re-exposing the oiled particles. This condition was never observed in clay and sand type areas, but was experienced in gravel and fine sediment beaches. Both factors 1 and 2 were relatively harmless as they

comprised less than 2% of the surface area and were usually less than the accumulation of jelly fish, debris, bottles and decaying seaweed. In case No. 1, the material was usually dry and solid; in case No. 2, the oil soon stabilized and became non-adhesive when separated from the main body of oil (two to four weeks).

To obtain a beach approaching completely oil free status (assuming heavy oiling), it was found necessary to have a group of labourers remove this material after four or five tidal cycles. This was done at the Point Beach, Petit de Grat and Half Island Cove. Fortunately, the most frequently used areas in the gravel type beaches were cleaned before June 15, and not used until mid-July. This allowed time for stabilization of the occasional oil particle which remained. No complaints were received by users in this regard.

OTHER MEANS OF BEACH RESTORATION

Only conventional earth moving equipment was used in the beach restoration program because:

(a) Initially, we did not know the capabilities and limitation of available machinery and hence we could not suggest intelligent modifications.
(b) The cost of such modifications would be relatively high. The type of heavy equipment used varied in price from $20,000 to $60,000. To have the most important areas cleaned before summer usage, it was necessary at times to use four contractors each with a number of units. For this operation, to use a similar number of extensively modified units, the cost of modification would be greater than the total cost of the restoration operation. Machinery specifically designed for oil removal from beaches would probably cost more than modified conventional types.
(c) No serious thought was given to this aspect because of the time involved in manufacturing and because of (a) and (b) above.

One modification that appears to merit further investigation is a new bucket design for a front-end loader, a longer, wider, less deep bucket which would remove, almost undisturbed, a slab of contaminated material. This would permit such machinery to work at full capacity and prevent the mixing of clean and oiled material resulting when the loader moves ahead to force material into the bucket. It could be interchangeable with the standard bucket.

One method attempted was to push the material down to the water at high tide. This resulted in a slick which re-oiled the cleaned area the next tide.

In another test area, the oiled material was raked by labourers using garden rakes. The oiled material had a 1/8" solid skin under which was semi-fluid oil. The disturbed material set up a slick when the tide came up; the oiled particles gradually flowed together and the surface began to harden. The end result was barely distinguishable from the initial situation.

It could be surmised that raking would hasten the natural oil removal action in dry oil contamination, but based on the Magdalene Islands experience with dry oil particles, this material would possibly be carried in and out, the majority of it eventually ending up on this beach or an adjacent beach.

On one occasion an experiment was conducted with the steam cleaning equipment used on wharves. A small area composed of clay and stone contaminated with oil was banked at the lower tidal zone and sides with peat moss to absorb the oil. The steam was applied until no more oil could be observed flowing off the test area. The experiment was not judged a success as the clay particles were not really clean; also the time required to steam the area, place and remove the peat moss was considerably more than other methods. Test holes dug before and after the application appeared to indicate an increase in depth of contamination.

As discussed in Part II, page 52 ,a motorized grader was used at Half Island Cove. It experienced difficulty maintaining traction. This area of the beach was shingle with an average oil depth of 2 inches, lightly scattered. The United States Federal Water Pollution Control Administration, in a project which evaluated earth moving equipment in oil contaminated beach restoration, found this machine to be very efficient in 1 inch oil depth penetration on flat, sandy beaches. They recommended flotation tires or rubber-belted half-tracks for situations where maintaining traction would be a problem. However, the majority of areas worked in our program were either loosely packed shingle or wet fine sand-silt-clay combination types. The depth of oiling was usually 4 inches or greater in the machinery removal areas; this, we felt, as did heavy equipment operators, would seriously impair the operation of a grader even if equipped with flotation tires or half-tracks.

RECONTAMINATION

The term recontamination is used in this report to refer to all oil contamination which occurred after the initial sinking of the tanker "Arrow" and after the subsequent arrival of this oil on the beaches.

This type of contamination came from a number of sources, the most prominent of which were:

(1) *Oil moving on the water from one section of shoreline to another, or adjacent area re-oiling.* Throughout the operation, this problem hindered the effective clean-up of certain areas. Generally, the source shoreline types were bedrock and boulders or clay and silt, i.e. surfaces on which the oil accumulated to appreciable depth rather than penetrated. At first, it was thought that a potential source could be identified from the fluid nature of the oil and the presence of iridescence, but this applied only to the obvious. With increasing land and air temperatures in late June and early July, adjacent area re-oiling revealed itself in another form. The oil on the rocks and the fine sediments became sufficiently fluid to move or be picked up by water action. The presence of a dry surface or skin did not prevent this as the oil would break through and slowly move down the surface.

Except in two instances (Fox Island Main & Limestone Beach) the amount of oil which came from this source was usually small, resulting in a thin black film, but nevertheless, sufficient to render the area unsuitable for recreation purposes. In some cases, patches or chunks of oil of 1" – 3" diameter would move to cleaned sections giving widely scattered oil particle contamination; in other cases, the contamination resulted in uniform blackening of a large area. The movement of the latter was usually detectible as it was accompanied by iridescence.

The Inhabitants Bay area shoreline and islands represented one of the most heavily oiled sections of Chedabucto Bay. The movement of oil between beaches delayed restoration procedures until late summer. Although iridescence was still visible in the vicinty of the islands, it was not sufficient to cause serious pollution. Only the Limestone Beach area suffered heavy adjacent area pollution.

In areas such as the western side of Janvrin Island and Canso Tickle, no serious restoration efforts were attempted as the movement of oil from shore to shore would have made such efforts futile.

(2) *Oil from the wreck.* It was difficult to distinguish between sources of recontaminating oil. It was not possible to be certain whether oil seeping from the wreck contributed at all to shoreline pollution. When a beach was being re-oiled from nearby shoreline sources, the iridescence could sometimes be seen extending over the intervening water. This was observed in Black Duck Cove, Canso Tickle, and from Rabbit Island to Janvrin. In only two instances of which we were aware was the oil traced directly from the tanker to shore after the initial pumping. Nevertheless, certain circumstances appeared to indicate this as a re-oiling source.

In the initial stages of the program, before increasing temperatures caused adjacent area pollution to become noticeable, re-oilings in Arichat and Deep Cove usually coincided with high winds from the direction of the wreck. Only from about June 25 until July 20, when unauthorized divers opened the wreck, was there any recontamination which could be associated with this source.

The opening of the tanker resulted in varying degrees of re-oiling in Cape Auget, Arichat, Janvrin Island and along the north shore of Inhabitants Bay. A slick was observed as far from the wreck as Melfort (south of Eddy Point).

(3) *Shallow Water Areas.* Oil deposited in sheltered coves, lagoons and shallow basins tended to remain in such areas during the summer. Protected from the wave action which removed the contamination on most shingle beaches and lessened it in other areas, they seeped varying amounts of oil depending on the temperature or the energy generated by the water at that particular time. During the cleaning program, no method of effectively dealing with this problem was devised, although steps were taken to lessen its severity.

Some of the areas concerned and the remedial measures taken are as follows:

(a) The shallow basins in Inhabitants Bay contained large amounts of eel grass. The dead leaves of eel grass would run with the oil and be deposited on the beaches. This contaminated seaweed would pollute clean beaches. The slick-licker operation kept this source to a minimum until suspended at the end of July. The proliferation of oiling by eel grass on the clean beaches in Inhabitants Bay which followed indicated the value of this operation.

(b) Lagoons, protected shallow coves and estuaries presented recontamination problems. The lagoons which gave the most trouble were those situated directly behind the beaches to be worked. The natural openings to the lagoons periodically close with the deposition of beach material, then open when the water height becomes sufficient to cut a new channel. When this occurred, oil from within would be carried to the adjacent shoreline. This situation existed at Babins Cove, Port Richmond and Seacoal Bay. In the first two cases, where the water within the lagoon was effectively isolated from the sea, a trench was dug, packed with fir boughs and the water released. The fir boughs effectively filtered out the oil. In Seacoal Bay, at high tide there were numerous wide channels from the ocean to the lagoon so this action could not be taken.

The coves which contained oil were usually exposed to wave action during a portion of the tidal cycle. However, this was sufficient to ensure a minimum amount of oil remained in these sources, hence pollution from this type of contamination was minimal.

Estuaries such as existed in Hadleyville #2 Contract and Seacoal could not be dealt with in any effective manner. In Hadleyville, a dozer removed and disturbed the oiled material. In Queensport and Halfpenny Pond a brush boom successfully prevented oil from coming out onto the beach.

Fortunately for the beach restoration program in Chedabucto Bay, the sinking of the tanker took place early in February and beach clean-up was not required until May. This allowed the oil which arrived on the shoreline to be stabilized to varying degrees. Based on our experience, it would be futile to attempt beach restoration where the oil was still fluid. The shoreline oil must be sufficiently solid that water action has little noticeable influence on it. The presence of iridescence in the water or of shiny, liquid oil on the beach indicates there will be some degree of contamination of adjacent unoiled shoreline.

Lagoons should be closed by filling in the entrance with a bulldozer before oil reaches the shoreline. Lagoons which cannot be closed in this manner along with estuaries and other shoreline water areas should be protected by booms. In addition to being areas where present clean-up methods are ineffective, they are usually wildlife feeding areas. To lessen the possibility of adjacent area re-oiling in the cove, they were usually cleaned from headland to headland if the extra distance was not too great or boulders were not present. In an attempt to lessen the effects of adjacent area recontamination and to permit clean-up of the heavily oiled Canso Tickle and a section of Inhabitants Bay that came to be known as the Limestone Beach, an experimental program of stabilization using limestone was conducted in these areas. Scientific co-ordination was supplied by Mr. Tom Foote of the Bedford Institute of Oceanography.

Initially, application using a sand blaster was tried unsuccessfully. After a number of unsuccessful trials (see page 72, Part II), a procedure was used whereby repeated light applications were made whenever fluid oil appeared through the hardened surface. This procedure, though expensive in terms of labour costs, did prevent recontamination from the treated areas. Application in both areas had decreased to once every two weeks by August 9 and was discontinued on August 24 — 30. Both areas remained clean during the applications and until about October 1. A survey on October 4 — 5 revealed that both areas were extensively re-oiled. Limestone was also applied to the mounds of oiled material pushed up against the backshore cliffs when removal was impossible. An analysis of the effectiveness of this means of stabilization or what actually happened is rather difficult. Apparently, the limestone hardened only the surface. During the warm summer weather, the fluid oil beneath this surface would break through and cause recontamination if limestone was not re-applied. During the September period, it appeared the storms and the natural movement of beach material removed portions of the surface thereby exposing the fluid oil. If re-application had been continued, possibly the cleaned beaches would have remained uncontaminated.

The effort involved in application and doubt about its effectiveness ruled out its use in large scale shoreline application, but it appears to be beneficial on accessible pockets of contamination if they are observed constantly and the limestone re-applied as needed.

ARICHAT

Part II

Data

Length	3,700 feet
Depth	3" to 6"
Width	60 feet – L.W.O.S.T. to base of cliff
Time	Started: April 30
	Completed: May 11
Contractor	Ivan MacKenzie
Value	$4,579.00
Cost/Lineal Feet	$1.22
Material Removed	720 tons
Cost/Ton	$6.20 (cost not representative as material moved within tidal zone)
Distance to Disposal	5.7 miles (Port Royal)

Equipment and Actual Hours Worked

The machinery was on the site from start to completion of the contract but due to tides worked the following hours:

IH-TD15 Dozer	39 hours
IG-TD9 Loader (trucked)	39 hours
Tandem Trucks	64 hours

This section of shoreline was generally composed of gravel, cobblesize rock and a few boulders underlain by fines, mostly silt and clay. Behind the shore is a till cliff, five to 20 feet high which is actively eroding in most sections. This cliff is the backyard boundary for residents of this section of Arichat, and consequently, cribwork boulders, etc., have been placed by some owners in the most active areas in an attempt to arrest erosion.

On the initial day of work the dozer entered the site by Le Noir Forge (centre of site) and proceeded to the western contract limits to start work. This road disturbed oiled material which then was picked up by the incoming tide and carried over the cleaned area. At this time, concern was expressed about the effects on the erosion of the cliff when the material (average depth of removal including rocks was one foot) was excavated. Depth of contaminated clay was four to six inches.

A procedure was developed, based on geological considerations, whereby in certain sections the material was either pushed up against the base of the cliff, removed completely, replaced or left undisturbed.

This project, being the area where machinery began work, provided some "Do's" and "Don'ts" which were incorporated into later contracts. They were:

1. The contract specifications had to be adapted in an attempt to cope with the unanticipated and to insert more flexibility, thus allowing the site supervisors more latitude in field decisions.

2. A large bulldozer (100 H.P. Flywheel class) with its blade perpendicular to the direction of travel was found to remove considerably more than required and to mix oiled and clean material. (See Part I for more discussion of this aspect.)

3. All material disturbed by machinery must be removed before the tide rises. Otherwise, an oil slick will be created which will blacken cleaned areas.

4. All large scale removal of sediment should be avoided in actively eroding areas.

Recontamination

Before the job was completed and on a number of occasions during the summer, the Arichat contract area experienced some degree of re-oiling. Some of the possible causes were:

1. During the course of the work, oil slicks covered sections of the cleaned beach. They were caused by:
   (i) Machinery travelling on oiled areas without prompt removal of material.
   (ii) Oiled material stockpiled within range of the tides. The water tended to wash oil out of these piles.
   (iii) Machinery working in the water.
   All of the above have been previously discussed. They were caused by improper use of machinery and resulted in a surface coating of oil of no appreciable thickness and were re-cleaned by the contractor.

2. Before sealing the wreck of the tanker, reports were received of iridescence slicks coming from that direction. On one occasion, a helicopter traced such a slick from the Arichat shoreline to the tanker. This source seemed to contribute only a minimum thickness of oil.

3. In May, a 2" – 3" deposit of oil was reported west of Le Noir Forge. Pickers were moved in immediately but within 48 hours the oil had penetrated to depths of approximately two feet. Work was discontinued as it was thought that this amount of material removal would endanger the adjacent property. It was planned to remove and replace this material later in the program. Tests on this oil revealed it was not from the tanker "Arrow".

4. Adjacent area oiling was a possible source but never observed in this area.

5. Oil washed down from the material pushed against the cliff blackening a one to two foot wide strip. This type of contamination was limited to sections where heavily oiled material was exposed.

It was impossible to discern the contribution of each source, as most occurred simultaneously.

The present state of this shoreline can be described as (a) deep oil pollution which is confined to the area adjacent to Le Noir Forge and (b) surface re-oiling over the remainder of the contract. This oil has now dried. A footprint reveals clean material.

BLACK DUCK COVE

Data

Location: Little Dover, Guysborough County, N.S. Situated approximately one mile beyond Little Dover Village after end of pavement.

Length	0.5 miles
Started	April 30,1970
Completed	May 12, 1970
Actual Days Worked	9days
Approved	May 14, 1970
Contractor	C.R. MacDonald Limited
Value	$6,000.00
Rip-Rap	4,460 cubic yards removed
Material	360 cubic yards hauled in
Equipment	Cat. 950 Loader — 78 hours
	Cat. D-6-C Dozer — 78 hours
	Tandem Trucks — 140 hours
	3-ton Trucks — 62 hours
Equipment Hours	Total: 358 hours
Disposal Area	Little Dover Dumpsite-3.6 miles
Cost per foot	$\frac{\$7,080.00}{2,640.00 \text{ ft.}}$ $2.68/foot
Cost per Ton	$0.91

Comments

The section worked consisted of a medium to coarse grained sand beach at the centre backed by a vegetated berm and brackish marsh.

The beach is generally about 100 feet wide but at low, ordinary spring tides up to 250 feet wide. Both ends of the section are composed of mud and silt. The north end was covered with some rock and boulders.

As this area contained varied beach forms and as it was one of the first two areas cleaned, it provided an indication at the time of the problems and capabilities of machine clean-up beach types commonly found in Chedabucto Bay.

The Contractor first worked the 1,000 foot sandy beach, then the rock-mud section and finally the bog or mud flat.

Two important aspects of the clean-up were reinforced or revealed on this job:

1. All excavated material has to be removed from the tidal zones before wave action removes the oil, setting up a slick. When the hardened surface on the oil is broken, any contact with water results in such an oil slick.

2. For the same reason machinery must never be allowed to operate or travel in the water.

3. The sequence of clean-up was wrong. The small rock-boulder-mud end should have been cleaned first because even at low tide, pools of oil and water remained trapped which at high tide were carried over the sand beach. The bog should have next been worked as it contained pools of oil and water which were impossible to remove with machinery. These pools of oiled mud, when disturbed, tended to clean during subsequent tides but contributed to an oil slick.
   The Contractor at the end of the job re-cleaned the sand beach.

The boulder removal stipulation – remove all under 1/2 cubic yard size – was not enforced as the boulders provided protection to the homes on the beach front and were in a high wave energy, actively eroding zone.

For the same reason, it was decided to replace the stone removed with rip-rap. The Contractor supplied and placed rip-rap for $3.00 per cubic yard.

The depth of oil varied from two inches to 36 inches and varied in different sections of the same beach types.

The cost per foot was relatively high. Actually, using the hours worked at Nova Scotia Road Builders Association rates, the cost would have been $5,318.00 versus $6,000.00 (the lowest tender). However, two factors influenced the above:

1. Reluctance on the part of Contractors to attempt an unfamiliar situation.

2. Machine operators and construction companies tend to work more efficiently under contract situations than on a pay by the hour arrangement.
   The cost per ton is very low.

Machinery could capably clean the sand beach. However, in the soft mud areas, some mixing of clean and contaminated material occurred. The loader was, at times, working in four feet of muck. After a few tides, this area appeared relatively clean.

Care was taken to protect the backshore areas from damage by movement of trucks and tractors. Travelling was limited to one track. Areas where the vegetation had previously been destroyed showed evidence of wind erosion.

Unfortunately, before the rip-rap was placed, oil floated down from the lagoon above the beach and later from the rocky headland directly across the cove from the lagoon.

This lagoon is composed of mainly large boulders and rock between which are deep pools of oil. It is inaccessible by land and in any case unworkable. This was our first experience with re-contamination from adjacent shoreline.

Re-oiling has continued during the summer. A boom was placed across the entrance to the lagoon but because of tidal conditions (almost a tidal bore) tended to tip over in some sections and this lessened its effectiveness.

BEACHES ADJACENT TO THE BAY OF ROCKS

Four beaches cleaned in this area are:

1. Rocky Bay North
2. Rocky Bay
3. Pondville
4. Pondville South (Little Barachois)

All were similar in material composition and oil contamination. With regard to beach types, all were fine-gravel beaches with sand in the tidal zones. Small storm ridges are evident in some locations as is a backshore till cliff. The sediment supply is ample in all areas.

These were the first beaches cleaned by pickers (labourers who shoveled the oiled material into plastic bags). No re-oiling has occurred. Original oiling was limited to scattered spots of no appreciable depth.

	Rocky Bay North	Rocky Bay	Pondville	Pondville South
Length (ft.)	2,120	2,400	2,640	1,120
Cost				
Pickers	$663.60		134.60	241.50
Hauling	288.60		144.00	150.00
Tonnage	140		50	35
Cost/ft. Labour	0.15		0.05	0.21
Other Costs: Repairs to road				460.80
Total Cost/ft.	0.21		0.11	0.76
Cost/ton	6.80		5.57	24.60

FOX ISLAND MAIN

Data

Location	Guysborough County, N.S.
	Approximately five miles from Canso
Length	840 feet
Time	Commenced: May 15, 1970
	Completed: May 20, 1970
Actual time worked	three days
Contract value	$2,000.00
Contractor	C.R. MacDonald Limited
Material removed	1,368 cubic yards
Equipment	Cat. 950 Loader - 36 hours
	Tandem Trucks - 40 hours
	D6-C Dozer - 9 1/2 hours (dump maintenance)
Cost/ft.	$2.38
Cost/ton	$\frac{\$2,000}{2,460 \text{ ft}}$ - $.81
Distance to dump	1.0 mile (Fox Island)

First Cleaning

June 11 — June 17

Picker costs	$ 319.20
Machinery costs	1,083.50
Total	$1,402.70

Second Cleaning

July 14 — August 8

Pickers	$2,942.80
Trucking	532.00
Machinery	312.00
Total 2nd cleaning	$3,786.80
Total cost	$7,189.50

This is also known as Indian Cove. It is a small concave pocket beach set back between two rock headlands. The beach is mainly gravel (minus1 1/2") with some sand especially in the intertidal zone. The slope of the beach is gentle and the sediment supply limited. This beach was contaminated above the normal high water mark with a six to 12 inch thick layer of oil of an average width of 10 feet.

At this stage, the clean-up program was still experimenting with techniques. It was decided to accept the Black Duck Cove contractor's price, on the basis of his previous performance, his interest in the projects, and his willingness to try suggestions on new approaches. It was decided to use only a loader rather than the bulldozer-loader-trucks combination used previously. The experiment was successful providing the loader was filled on each scoop only to a capacity which did not allow spillage, i.e., about one-half full, and the operator and inspector remained sufficiently alert to pick up scattered spots of contamination outside the heavily oiled cross-section. Although variations of this method were tried from time to time, this technique was found most effective in terms of machinery efficiency and oil removal for a deeply oiled cross-section on a shingle beach.

After removing this trench of material, the beach was sloped to a uniform gradient pushing material from the storm ridge or the lower tidal zone.

On May 25, the eastern 300 feet was observed to be badly oiled in the high tide zone; after analysis it was thought to have come from adjacent rocky areas which contained pools of oil trapped in crevices between boulders. These pools resulted from the oil flowing off the boulders due to the warmer temperatures, accumulating over several days because they were exposed to wave action only during the monthly high tides. The water at this time picked up the water-in-oil emulsion and carried it over the beach.

A remedial program was initiated whereby the pools were scooped out, and sand and limestone applied to rocks and the crevices to stabilize the semi-solid oil. This was successful and after re-cleaning the beach remained clean for approximately one month.

After June high tides, contamination was again observed on the east end. Investigation of the previous source showed a sufficient degree of stabilization but the west end was found to have a similar source of potential pollution. The portion of this rocky headland adjacent to the shore had been checked but the actual source was some distance from the beach and almost inaccessible by land and sea. The remedial action was as before except only limestone was used. A road had to be cleared and a ramp built to slide the bags of limestone down a 30 foot cliff. The limestone was applied lightly over a three-week period; the first week — five applications, the next two weeks — three and two applications respectively. It was applied when the oil showed evidence of beginning to flow. Twelve tons were used. During the three weeks to the time of report writing, the rocks have remained stabilized and the beach clean.

HALF ISLAND COVE, HADLEYVILLE #1 and #2

These three beaches represent almost identical oil contamination situations and are similar in geological structure.

Half Island Cove is a wide shingle beach with a maximum width of 80 feet. The lower tidal zone is composed of fines and gravel while the upper beach zone and storm ridge is shingle. The along-shore movement of the material appears to be from east to west. The beach at one section is backed by a 20-ft active till cliff. Another section has a lagoon at the rear. The central 200 feet was excluded from the contract as it contained bedrock and boulders. The area worked consisted of 1,500 feet of recreation beach and 700 feet adjacent to the Government wharf (eastern end of cove).

Most of the contamination material was above the tidal zone in a 10 – 20 foot wide strip. As this is a regenerative beach, some clean gravel had been pushed over the oiled material giving the appearance of large spots of oil.

The eastern end of the cove and the breakwater section was more heavily oiled, with the latter almost uniformly covered. The eastern end of the 1,500 foot section had two to three feet of contamination while the western end was oiled to an average depth of one foot.

Hadleyville #1, located on the north-west of Chedabucto Bay, is similar in material make-up. It is a well developed steep shingle beach but has a greater proportion of large size particles than Half Island Cove. The inter-tidal zone varies from 80 to 100 feet.

Oiling here was similar to Half Island Cove only deeper. The eastern end contained some pools; the removal depth was up to five feet; the average depth over the rest of the beach was three to five feet.

Hadleyville #2 is located north of Hadleyville #1 and south of Cape Argos. This beach contains more sand than the others. The northern end is all sand except for a storm ridge of gravel and rock, approximately 12 feet wide, and located immediately above normal high tide marks. Towards the southern limit, the beach gradually changes until it resembles the two previously discussed beaches in composition.

The amount of contamination was greater here, in both the predominantly sandy and gravel sections. The gravel section contamination pattern was similar to that found in others but the sand section was above the tidal zone with depths of three to five feet in the storm ridge. There were large pools of oil on the surface of the sand above the tidal zone. The depth here averaged 1.5 feet.

The following table gives the data on cost, time, etc., for the three areas:

	Half Island Cove	Hadleyville #1	Hadleyville #2
Length/ft	1,500 + 700	4,400	3,670
Time: Commenced	May 15	June 3	July 6
Completed	June 12	June 11	July 20
Days worked	5	7	11
Contract cost	$3,000 + 1,500	$9,450	$8,495
Actual cost including picking	$4,980		
Cost/ft	$2.28	$2.15	$2.31
Tonnage	3,422	7,219	9,840
Cost/ton	$1.45	$1.31	$.87
Distance to dumpsite	6.0 mi.	5.4 mi.	3.0 mi.
Dump	Fox Island	Sand Point	Sand Point
Equipment			
Cat. 950 Loader	59	98	169 1/2
Cat. D6-C Dozer		39	
Tandem Trucks	62	237	

The importance of having a disposal area close to the work site when large quantities are involved is reflected in cost/ton figures. A price of $1.31 for the cost/ton and a cost/foot of $2.25 represent the usual price paid for this type of clean-up. Most of the contamination was located above high tide, hence the contractor could make optimum use of his machinery. Studies indicated an average rate of removal under these conditions was 1,400 square feet per hour for a three foot depth.

Here, as on all beaches, equipment operators found tandem trucks (dual rear axles) to be the most efficient conventional haul unit. The loader-truck combination of equipment was used in all areas except the south eastern end of Hadleyville #2 where it was impossible to haul the oiled material out. Here, a dozer was used to push the oiled sand up to prevent contamination.

At Half Island Cove, considerable oiled material remained after the initial cleaning. Our field inspection was retired and the contractor was requested to return to finish the job. On June 12, he did, and the final job was satisfactory. One probable reason for this was that it rained during the initial cleaning making it difficult to distinguish between wet dark beach material and lightly oiled stone.

After a few tides, scattered oiled rocks were revealed in all areas. This was attributed to the "sediment shield" effect discussed in Part I. Separated from the main body of oil, these spots soon hardened, becoming non-adhesive and harmless. The total surface area occupied by such material was less than 1 per cent of the beach area.

Experiments with a road grader at Half Island Cove were not successful. This area was chosen because it contained a large portion of fines, hence the tractive qualities were better than most shingle beaches. The grader was not able to work on the lower tidal areas and the efficiency of cleaning was less than the loader.

The clean material removed usually consisted of a $2'' - 3''$ layer around the almost rectangular cross-section of contamination. As all beaches in this area have an ample sediment supply, this was not considered harmful.

JANVRIN HARBOUR

DATA:

Location:	Area adjacent to Government Wharf
Length:	1,085 feet
Depth of Oil:	2" – 5"
Width:	Average of 60 feet
Time:	Commenced: June 2
	Completed: June 4
Contractor:	MacKenzie Brothers
Value:	$1,240.00
Cost/ft.	$1.14
Equipment and hours worked:	
Komatsu D50A Dozer	13 1/2 hours
TD-9 Loader	13 1/2 hours
Tandem Trucks	29 hours
Material removed	312 tons
Distance to disposal	7.6 miles

This contract was composed of a 150-foot section east of the wharf plus 935 feet on the west. The beach is mainly silt, mud, and sand. Behind the beach is a cliff of average height (1 ft.) on the center west, rising at each end to about 6 feet.

The west shore bounds a sheltered section of the harbour thus allowing fine sediment deposition. Erosion is more pronounced towards the eastern limits.

Preliminary estimates of tonnage removal costs indicate that about 1000 tons would be removed at a cost of $2,000. This was based on the premise that a high percentage of clean material would be removed because its oil depth was in the 2" – 3" range.

Prior to this, experiments with a grader had proved unsuccessful, but when writing the Janvrin Harbour specifications, it was decided to recommend a tracked dozer with its blade angled to the direction of travel. The type used by the contractor had one adjustment of 45 degrees.

The material was bladed into long rows, usually by two passes on the water side and one on the upper. These rows were then removed with a loader. This method proved successful for this beach type. As the quantities (much smaller than preliminary estimate) indicate, the amount of clean material removed was almost negligible.

The western section is used by fishermen to haul up their boats and also by the residents as a swimming area. No re-oiling has taken place.

SAND POINT

DATA:

Length:	2,800 feet cleaned
	500 feet rip-rap
	3,300 feet total
Time:	Commenced: June 11
	Completed: June 23
Equipment:	
5 Tandem Trucks	180 loads
Cat. 950 Loader	82 hours
D6-C Dozer	22 hours
Costs:	
Original contract cost	$4,495.00
Rip-Rap	2,340.00
Footage cleaned	4,000.00
Actual cost	$6,340.00
Material excavated:	3,600 tons
Depth of oil:	2 feet – 4 feet
Original contract cost/ lineal foot	$\frac{4995}{3300} = \$1.36$
Amount cleaned/lineal foot	$\frac{4000}{2447} = \$1.36$
Amount covered/lineal foot	$\frac{2340}{500} = \$4.68$
Cost/ton of material removed	$\frac{4000}{3600} = \$1.11$
Distance to dumpsite:	1.5 miles (Sand Point)

This project is located on a point of land protruding into the Strait of Canso and is composed of two beaches. The north is eroding at an estimated rate of 1 foot/year, the point and the south beach are being built up.

On the point is a D.O.T. lighthouse, while in the centre of this land area, behind both beaches, is a lagoon. Both beaches are composed mainly of gravel.

The oil contamination was usually confined to a 5 to 20 foot wide strip adjacent to the high tide level. The depth observed early in the season was less than 24" with the majority of test holes indicating 12".

However, actual clean-up required 2 to 4 foot removal, with one location at 7 feet. This depth of contamination was reported in other loosely packed, low fine material content beaches and appeared to be due to the increasing land temperatures.

After awarding the contract, it was decided to place rip-rap over the actively eroding section of the north beach. Consequently, 500 lineal feet of contamination was covered with 585 cubic yards of stone.

The reasons for this decision were:

1. An appreciable amount of material would have to be removed; a section worked by the contractor indicated a depth of up to 5 feet.

2. The absence of a storm ridge and a small tidal zone would make it difficult to move gravel into the excavated area for sloping this shore after cleaning.

3. Both of the above would contribute to the already active rate of erosion.

4. The owner of the property directly behind the erosion zone objected to the removal of large amounts of material because of the active erosion. He was involved at the time in a dispute with D.O.T. over access to lighthouse property, claiming that the D.O.T. road had already eroded away and they were driving on his land. He had a "NO TRESPASSING" sign on his property. He stated he would be happy to have rip-rap placed to arrest the erosion and would in return provide access to the D.O.T. property. This was done.

The bidding on contracts by this time was highly competitive.

If this job had been done by equipment rental, it would have cost at least $5,400.00 vs $4,000.00.

The contractor agreed to break the contract and be paid for each lineal foot cleaned at the following rate:

$$\frac{\text{Value of contract}}{\text{Total lineal footage}} = \text{rate/foot}$$

He agreed to supply the rip-rap at $4.00/cubic yard.

The method used was the loader-truck combination and again was effective with this type of oil and beach material. No oil recontamination was observed to have come out from under the rip-rap. The north beach is now being used extensively.

QUEENSPORT AND CANSO BREAKWATER BEACH

QUEENSPORT

DATA:

Length	1,500 feet
Depth of Oil:	2" – 6", Average 6"
Width of Oil:	5' – 20', Average 5'
Time:	Commenced: June 16
	Completed: June 30
Days worked:	2
Re-cleaning costs:	
Pickers	$5,691.25
Picking cost/lineal foot	$ 3.80
Cost of removing material	$1,998.00
Total cost/foot	$ 5.30
Number of tons	480
Cost/ton	$15.80
Distance to dumpsite:	14 miles

This beach is of the same material type as Fox Island Main, Half Island Cove, Hadleyville, etc., except that the rate of replenishment is low.

The only point of interest on this job is that cost breakdown indicates the high cost of using hand labour to remove the contaminated material when the depth is upwards of six inches. The cost/foot, however, resembles Moose Bay which represents similar circumstances.

CANSO BREAKWATER BEACH

DATA:

Length:	280 feet
Contractor:	C.R. MacDonald Limited
Value:	$750.00
Cost/lineal foot	$2.68
Number of tons removed:	500 tons
Cost/ton	$1.50
Disposal distance:	4.0 miles (Little Dover)
Equipment and actual hours:	
950 Loader	17 hours
Tandem Truck	17 hours
Days worked	2

This beach was composed of fine sand with a few rocks scattered over the surface. Rocks and the remains of jetties mark the limits of the beach. It is used for both recreation and fishing.

The contamination consisted of a blanket of oil which had penetrated the sand 6" to 8" from mid-tide. Below mid-tide level, oiling depth rapidly tapered down to traces. The width was approximately 60 feet.

Two relevant points came out of this job:

1. Tenders were called on this project to check our assumption that prospective bidders would not be interested in jobs under a certain size, i.e. under 1,000 feet for moderate oiling. This was confirmed when only one bid was received, and this was by C.R. MacDonald Limited whose policy is to submit a price on all operation oil contracts. The price, though somewhat high, was not unreasonable and was accepted.

2. This was the first occasion on which only a loader was used for removal of a moderate depth of uniform oiling. This technique was successful in terms of cleaning the beach but tended to remove more clean material than a small dozer with its blade at an angle, especially when the material dropped below three inches.

PHILIPS HARBOUR

This cove is mainly a gently sloping fine gravel beach with a limited sediment supply.

The eastern end has a well developed storm ridge on which fishing buildings and skidways are located.

Both ends are bounded by large rocks.

The beach was contaminated as follows:

The south and western sections contained a heavy scattering of patches of oil. The penetration of this oil was usually from 1" to 4". There were some sections of rocks adjacent to the low water mark which were covered with a coating of surface oil. The eastern section was oiled for a 10 to 20 foot wide section, 8" to 14" deep.

In view of the slow rate of replenishment of gravel on the south and western sections, and the possible consequence to the skidway and building if large amounts of material were removed in the eastern section, it was decided:

1. To use "slick pickers", whenever oiling penetration was small enough to make this economical.

2. To remove the heavily oiled portion with machinery hired on an hourly rental basis. The area to be decontaminated was too small to be of interest to prospective bidders and the instructions had to be flexible. Delays would be encountered as skidways were moved and then replaced. Fishermen were using this area.
   The actual removal and replacement (next item) would have to be almost simultaneous and would require direct supervision and co-ordination by the Field Inspector and would be on as "we'll see what to do as we proceed" basis (depending on oil depth and location). This would be impossible to write into a contract.

3. Gravel would be hauled in to replace that removed from in front of the fishermen's buildings. The source was Half Island Cove's middle to lower tidal zones.

Length:	600 feet
Machinery:	
Cat. 950 Loader	34 1/2 hours
Tandem Trucks	56 1/2 hours
Cost of machinery including float time:	$1,414.25
Cost/lineal foot	$ 2.36
Picking Cost:	$ 828.20
Cost/lineal foot	$ 1.38

The per foot cost does not represent a cost comparison of methods as pickers worked the lightly oiled areas.

Material hauled out from equipment operation:	960 tons
Material hauled out from labour operation:	330 tons
Material hauled in:	560 tons
Cost per ton — equipment:	$1.48/ton
Cost per ton — Pickers:	$2.50/ton
Distance to disposal area:	7.5 miles (Fox Island)

Note: Machinery tends to move more material than required.

One month later, pickers returned to Philips Harbour to remove patches of oil which had floated in. Approximate cost: $45.00

The clean-up program at Philips Cove was successful. The beach is free of contamination except for the occasional blob which floats from adjacent rocks.

This recontamination is very small, as indicated by the re-cleaning costs. However, it appears the quality of the work was not appreciated by the residents and although no complaints were received in regards to the cleaning, the "can of worms" effect was generated by the replacement of material in a certain area. Almost all residents with water frontage requested we replace "their gravel". This was not possible or necessary, as we informed them, because:

(a) The material was removed from the tidal zone and would be replaced by natural deposition action. No material was taken from beyond normal high tide mark.

(b) This would be a dangerous precedent. It would be impossible for all areas cleaned as there was not sufficient clean gravel in the area.

MOOSE BAY

DATA:

Location: Located at Moose Bay (Clam Harbour), Guysborough County, N.S. – adjacent to the community of Port Shoreham.

Length:	Contract length is 4,400 feet
Disposal area:	Sand Point Dumpsite – 13.5 miles
Time:	Commenced: June 26
	Completed: July 8
Days worked	8
Contractor:	C.R. MacDonald Limited
Value:	$6,995.00
Cost/lineal foot:	$ 1.58
Material excavated:	5,049 tons
Cost/ton	$ 1.37
Equipment:	
Cat. 950 Loader	96 hours
Tandem Trucks, 224 loads	300 hours
Pickers Operation on Moose Bay:	
Time:	Commenced: May 19, 1970
	Completed: June 15, 1970
Cost:	$17,986.00
Length cleaned:	5,260 feet
Cost/lineal foot	$\frac{17,986.00}{5.260 \text{ ft.}} = \$3.42$
No. of tons:	4,000 tons
Cost/ton:	$\frac{17,986.00}{4,000 \text{ ft.}} = \$4.50$

Geologically, this beach is similar to the previously discussed beaches on the western side of the Strait of Canso.

It is a well developed gravel beach with a plentiful sediment supply and a large storm ridge. Except for the storm ridge, the gravel is in the minus 1" size range. On the eastern end is Ragged Pond, in the centre, a river called Clam Pond which empties into the Bay, while on the western end, behind the beach, is Stewarts Pond.

Oil contamination resembled that of other beaches of this type and area, varying only in depth. The contamination was limited to a 5 to 25 foot wide strip close to the high tide mark and depths of 6" to 48". Generally, the oil depth increased from east to west.

Pickers were started in the most lightly oiled area. Eventually, a work force of approximately 60 men was mobilized; farm tractors and wagons hauled the plastic bags of material to a loading area where trucks moved it to the dumpsite.

The picking operation was successful where the oiling was less than 6 inches deep and removed a minimum of material. However, as the depth increased, the pickers' efficiency decreased. A bag-holder device was constructed using two rings and three legs of 1/4" steel. The plastic bag was attached inside and the stand would support it while being filled. It was thought that an increase in production would result because no one would be required to hold the bag while it was being filled. However, time-motion studies indicated that no increase in productivity resulted; the increase in production was nullified by the increased time needed to place the bag in the stand.

During the latter days of the picking operation when depths of 1 foot were encountered, the cost reached approximately $5.00/foot. A considerable amount was being left due to the "sediment-shield effect" and consequently it was necessary to put the remaining 4,400 feet out to contract. The western end of the project contained a small cove which was heavily oiled under the low tide level. At this stage of the operation, it was possible to predict the cove as a potential re-oiling source. It was written into the contract specifications that the contractor attempt to clean this area initially, even though it was known that underwater oil could not be efficiently removed. It was felt that some would be removed and the remainder disturbed, hence accelerating wave action clean-up.

The resulting contamination would be picked when the remainder of the clean-up was effective.

A cost comparison can be made between labour and machinery on this project to evaluate each method in a heavily oiled beach. It is definite that only machinery is effective and efficient when the depth of penetration of the oil is considerable.

Recent observations indicate the sediment shield effect was more pronounced in the labour cleaned section.

Both sections are now being used extensively for swimming.

BEACHES EAST OF ST. PETER'S

All the beaches on this shoreline have an ample supply of sediment, usually with sand and light beach stones. The construction of a dam at Lennox Passage prevented oil from entering some beaches in St. Peter's Bay and from recontaminating the beaches that were cleaned.

The contamination was generally light to moderate, and on most beaches was on the surface. The width of oil varied from 20′ to 75′ and the depth was 2″ – 4″ with slightly more in the areas cleaned by machinery. This area is suitable for "slick pickers", i.e., labourers equipped with shovels, who removed the oiled material and placed it in plastic bags.

The pickers' operation worked well in this area where there was surface oil and they removed only the contaminated substances. The area has remained clean.

DATA

	Feet	Tons Cost		Machinery
Point Michaud	7100	300	$ 3280.20	$1578.50
St. Esprit	4500	163	1992.90	1270.99
Gracieville	4800	400	1089.90	2439.00
Grand River	500	5	136.50	36.65
Godie Point	1000	70	514.50	230.10
L'Ardoise Area	7700	285	3143.70	2788.05

	Total Picker Cost/Foot	Total Cost/Ton	Cost/Ton For Cleaning
Point Michaud	$0.68	$16.20	$10.93
St. Esprit	0.73	20.09	12.23
Gracieville	0.74	8.82	2.72
Grand River	0.35	34.63	27.30
Godie Point	0.75	10.64	7.35
L'Ardoise Area	0.77	20.81	11.04

This difference between the total cost/ton and the cleaning cost/ton represent hauling and dumpsite maintenance costs.

The cost/ton for Gracieville is low as machinery cleaned 80% of the area.

POINT MICHAUD

It is an excellent sandy shore extending for more than a mile in a semicircular pattern. The oil on Point Michaud was scattered in blobs on the surface of the sand. Consequently, "slick pickers" were most effective here as the oil was 1" – 4" deep, (generally 1").

The oiled material was shovelled into bags and trucked to the municipal dump at l'Ardoise. A four wheel drive Dodge Power Wagon, a one-ton truck and a tandem were used to remove the bags of oiled material. The dump site was covered regularly as stipulated by municipal authorities.

Clean-up of Point Michaud was successful, economical, and the area remained clean.

GRACIEVILLE

Gracieville together with Point Michaud forms a well developed tombolo connecting a rocky island.

Only one-fifth of the beach was cleaned by pickers. The vegetated areas along a bank adjoining the beach had varying amounts of oil in it. This bank was cleaned using a loader as the material was too heavy for pickers. Where the vegetation was lightly oiled, it was not cleaned so as to reduce the probability of wind erosion.

A tree farmer was used to haul the bags to a loading area so the trucks could haul them to the dump. The tree farmer is a 4-wheel drive vehicle, with large tires, a winch, and a loading platform. It is used in logging operations.

ST. ESPRIT

St. Esprit beach was done completely by pickers. Utilization of the tree farmer enabled the material to be hauled to a loading area for the trucks. The beach was typical of all beaches in the area.

GRAND RIVER

Grand River, Godie Point and the beaches in the l'Ardoise area, Rockdale, Burkey's Cove, Chapel Cove and Martin Point were all cleaned by pickers. The same methods were used, except at Martin point where the east end was more heavily oiled and a loader was used.

INHABITANTS RIVER AREA

This area, which was very heavily oiled, created two problems, one being that cleaned small sections would be re-oiled from the adjacent shoreline. Another problem which arose was the inaccessibility of the shoreline for removal of the material.

Only in two of the six areas cleaned did there exist a usable road to the beach. The terrain between the river the highway was often swampy; also, a vertical 10 – 15 foot cliff bounded the backshore. These areas were usually used by the local residents who walked to the shore.

The beach surface was composed of small stone and clay.

A boom placed across the mouth of the river prevented re-oiling from Inhabitants Bay, and consequently, by July the shore had sufficiently stabilized to attempt cleaning.

In the inaccessible areas, the material was simply pushed up against the backshore cliff making certain all oiled material was covered with clean material.

These beaches remained clean possibly because the adjacent areas have stabilized to some degree and the small amount of wave section in this river did not leach the oil out of the "pushed up" material. The oil did not penetrate the beach material beyond a depth of 5 inches in the sections worked.

INHABITANTS BAY BEACHES

This section deals with the beaches on the north shore of Inhabitants Bay. The five areas worked were:

(i) Seacoal Bay

(ii) Port Malcolm

(iii) Port Richmond

(iv) Walkerville

(v) Whiteside

Generally, this shoreline is unvarying with regard to material type, consisting of a surface of rock, pebbles underlain by mud, and silt. Bedrock is sometimes close to the surface (1 foot). The intertidal zone is narrow and the sediment supply is limited; one source is material from the erosion of a 10 to 20 foot cliff behind each beach. One section of Seacoal project involved clean-up of the bar.

The pollution consisted of a blanket of oil from high to low tide levels. The depth of penetration varied from 1″ to 12″ and decreased as the fine material increased. Generally, 4″ to 6″ of material had to be removed. Seacoal and Limestone Beaches had the greatest depth of oiling. Most of Whiteside had no appreciable penetration, thus the oil had absorbed beach material, dried up, and "flaked off", permitting the use of pickers.

STATISTICAL BREAKDOWN

Data:	Seacoal	Port Malcolm	Walkerville
Length (feet):	1584	1075	2850
		550	
Time: Commenced	June 26	July 15	June 27
Completed	July 7	July 26	July 20
Actual days worked:	8	3	8
Method used:	Machinery	Machinery	Machinery
Contract value:	$2730.00	$1990.00	$3135.00
Actual cost:	$2730.00	$1990.00	$3135.00
Cost/foot:	$1.72	$1.23	$1.09
Contractor:	MacKenzie Brothers	F.W. Digdon	F.W. Digdon
Material removed:	2592 tons	1248 tons	720 tons
Cost/ton:	$1.05	Δ $1.57	Δ $6.35
Disposal site:	Doyle Rd.	Doyle Rd.	Doyle Rd.
Distance to dumpsite:	14 miles	8.5 miles	5.0 miles

Δ Not applicable. Cost includes moving material up to base of cliff.

Data:	Port Richmond	Whiteside
Length (feet):	1000	800
	350	
Time: Commenced	July 22	June 13
Completed	July 27	June 20
Actual days worked:	4	4
Method used:	Machinery	Machine Rental plus Pickers
Contract value:	$2245.00	Rental $612.00
		Labour $126.00
Actual cost:	$3376.88	$738.00
Cost/foot:	$ 2.53	$ 0.92
Contractor:	F.W. Digdon	
Material removed:	1544 tons	204 tons
Cost/ton:	$ 2.18	$ 3.61
Disposal site:	Doyle Rd.	Port Royal
	Port Royal	
Distance to dumpsite:	16.7 miles	
	17.0 miles	

The equipment used and the hours worked are:

Seacoal Bay	
D505 Komatsu Dozer	36.5 hours
TD9 Caterpillar	36.5 hours
3 Tandem Trucks	126 hours
Port Malcolm	
D4 Dozer	21 hours
TD9 Loader	16 hours
6 Tandem Trucks	135 hours
Port Richmond	
450 Case Dozer	32 hours
977 Caterpillar Loader	16 hours
Tandem Trucks	94.5 hours
Walkerville	
Case 450 Bulldozer	60 hours
977 Caterpillar Loader	41 hours
2 Tandem Trucks	25 hours

The above hours represent the actual time worked. All the projects in this area had to be worked between tides, hence the machinery was on the site longer than indicated by these figures, and usually from start to completion.

The method of clean-up consisted of using a dozer with angled blade and a loader to pick up the rows of bladed material and place it into trucks. An effort to determine how much clean material was removed with the contaminated was undertaken. It was found that at uniform depths of 1" – 1 1/2", clean material was usually removed regardless of the penetration. In varying depths, less than 2 1/2" – 3" of clean material was removed. Also, a study was made to estimate the time to clean this type of beach under optimum conditions. The results indicated for 3" – 4" depth, 6,000 square feet/hour could be removed while for 6" – 14" depths, it was 3,500 square feet/hour.

In Walkerville, after the surface of oil was removed, it was found impossible in some sections to travel with trucks. As there was only one access, this slowed down the removal of material, the rate being limited by what a loader could carry to the access road. Eventually, the loader was unable to travel. A small light tracked dozer was then used to push the material up against the base of a cliff. Where this material appeared likely to leach down over the beach, limestone was applied. The unworkable areas were always where the water table was close to the surface; the coat of oil obscured the nature of the material. By the time the contract was let for Port Malcolm, the situation was recognizable and the "push-up" procedure was specified for 550 feet of the contract length.

The cost per unit for Seacoal is not representative as the contractor lost approximately $600.00. The difference between the contract and actual cost for Port Richmond represents (a) overhaul costs; the road to the specified dumpsite became unusable, (b) one half the cost of recleaning the limestone beach.

Behind both Port Richmond and Seacoal Bay, lagoons containing oil provided a source of recontamination. The lagoons were oiled during high tides when the initial oilslicks covered these areas. Seacoal lagoon was too large to take remedial measures. Consequently, the bar was gradually blackened after clean-up. A ditch was constructed between the Port Richmond lagoons and filled with fir boughs to filter out the oil. The Limestone Beach lagoon was seeping oil-water emulsion when clean-up was started.

The clean-up in this area was delayed until the end of the program because of the amount of unstabilized oil on the beach and the potential sources of recontamination (heavily oiled islands, and floating oil in Inhabitants Bay). The limestone beach contained fluid oil between rocks and thus was most susceptible to "adjacent area re-oiling". It was decided this area would be used to evaluate limestone as a stabilization agent. Initially, a small area was liberally coated with limestone but it was re-oiled, probably from adjacent beaches and from the oil pools which formed within the area itself. A second attempt was made. This time approximately 1,000 feet was treated; two more applications were used on the pools. The area remained relatively dry for five days; gradually pools of oil emerged from under the hardened surface and flowed down the beach eventually recontaminating approximately 75% of the area. It appeared that the pools within the treated area were the main sources of contamination. Consequently, a third attempt was made. This time, the limestone was applied in amounts only sufficient to cover the oil but was reapplied to the pools whenever they became evident. At time of writing (October 1970) this is continuing, usually only on a bi-weekly basis. Stabilization is now approximately 100%, and the 350 foot section of beach which has since been worked has to date remained relatively clean.

Despite the potential re-oiling sources previously discussed, the area remained clean except for Seacoal Bay until July 25. All areas experienced some re-oiling when the tanker was opened by unauthorized divers. An agreement was made with the contractors to re-clean the limestone beach with our operation absorbing one half the cost. Unfortunately, the oil from the tanker prevented an evaluation of the re-oiling from other sources. However, the presence of oiled seaweed at the high tide mark indicates some contamination from the islands in the Bay. The re-oiling was confined to a one-foot wide strip at the normal high tide mark.

PETIT DE GRAT AREA

The beaches cleaned in the Petit de Grat area were:

Sampson's Beach	Boudreauville Breakwater
Petit de Grat Bridge	Petit de Grat South
Petit de Grat Point	Petit de Grat South (Gus Marchand)
Gros Nez	Petit de Grat (Boudreau's Fish Plant)
Boudreauville	

This area consists of many pocket beaches whose boundaries are limited by rocks, ledges, boulders and cliffs. Since these beaches replenish themselves slowly, our method of cleaning has been mostly by pickers. As a result, a minimum amount of material was removed. The beaches were mainly shingle type with sandy sediment at the lower tidal zone.

The oil on these beaches was mostly superficial with depths of 2 – 4 inches. The width varied with the individual beaches but the oil contamination averaged 10' to 15' situated near the upper tidal zone. Unlike Arichat, little re-oiling has occurred in this area. Machinery was used only where picking was not feasible.

DATA

	Length (feet)	Tons	Cost $	Average cost/ft.	Average cost/ton
Sampson's Beach	350	125			
Petit de Grat Bridge	120	9			
Petis de Grat Point	300	193			
Gros Nez	250	75			
Boudreauville	340	243			
Boudreauville (break water)	400	179			
Petit de Grat South (Gus Marchand)	125	198			
Petit de Grat, Boudreau's Fish Plant	150	40			
Boudreauville (contract)	280	150			
Petit de Grat South (contract)	300				
Machinery			$4,722.95		
Pickers			$5,304.04		
TOTAL	2615	1332	$10,026.99	$3.83	7.53

DEEP COVE

The area referred to as Deep Cove in this report comprises both sides of a bar joining two islands between Janvrin Island and Isle Madame.

The movement of sediments is predominantly from west to east. Consequently, there is a varying particle size distribution where the water, as its velocity decreases, ceases to move the gravel and starts depositing the sand, clay and silt. On the western end of the south shore is an actively eroding cliff. In the cove at the eastern end, the material varies from mud at lower tidal zones to sand in the upper. The north shore is an area of gravel deposition (fig. 1). This bar provides a tenuous link between the islands and if severely breached would probably not heal due to water movement.

All sections were covered with a blanket of oil contaminated material that ranged in depth from 3" in the fine material to at least 4 feet in the coarse gravel. It extended in the bar section from low tide on the north shore to low tide on the south. On the south, the depth of oiling decreased from the high to low water mark. In the eastern cove, the contamination extended from below low tide into the grass above the beach.

In view of the morphology and the oiling situation of the area, the following procedure was planned:

1. To use pickers wherever possible. This would mainly be limited to the mid to lower tidal zones on the south side of the bar section and the upper portion of the beach in the centre eastern section.

2. To leave the roadbed intact on the bar. The oil has almost stabilized with the gravel, providing a good driving surface. Approximately 2 inches of clean gravel was placed over the road.

3. To remove a triangular cross-section on the south shore of the bar to a vertical depth of 4 feet, as required, and to replace it with gravel from the south eastern section of the cove. Considerable oil remained on the surface from the edge of the road down to the high tide mark. This oil tended to flow down the beach in the warm weather.

4. To use a dozer with its blade on an angle to remove the fine material in the centre south eastern end.

5. To remove the contaminated material down to a safe depth on the north shore and replace it with material from the far south eastern end and the lower north shore tidal zones.

It was estimated the clean-up would be difficult and costly. The clean-up was accomplished in three stages. They were:

1. This phase of the operation consisted of picking the upper zone of the centre section of the cove and also the lower zones on the eastern section of the south side of the bar. The oil flowing down from the edge of the road delayed the remaining picking. Machinery work under this phase consisted of the angled-bladed dozer operation previously described.

The cost, time and equipment breakdown were as follows:

Pickers

Time:	May 25 – May 30 June 1 – June 3
Cost:	
Labour:	$2.01/hour
Total including 153 (time + 1/2) overtime hours	$1799.53
Trucking	518.50
Total	$2318.03
Material	380 tons

Machinery

Time:	June 1 & June 11 – 16 inclusive
Equipment and hours:	
TD9 Loader	38 hours
Komatsu Dozer D50A	34 hours
Tandem Trucks	56 hours
Total machinery cost	$1711.00
Material removed:	1248 tons
Total cost Phase I:	$2318.03
	1711.00
	$4029.03
Total tonnage:	1628 tons
Length:	750 feet
Cost/lineal foot	$ 5.37
Width	60′ – 110′, average 90 feet
Cost/ton:	$ 2.44

2. This phase consisted of picking the western end, south shore of the bar. The length was 450 feet while the width was almost constant at 30 feet.

Time:	June 15 – 21 inclusive
Cost:	280 regular hours
	120 overtime hours
Picking cost:	$804.00
Trucking:	$125.00
Total:	$929.00
Tonnage:	93 tons
Cost/lineal feet	$ 2.05
Cost/ton	$ 10.00

3. This phase of the operation consisted of the removal and replacement of material on both sides of the bar.

Time:	June 23 – June 30
Days worked:	8
Equipment:	
Float	6 1/2 hours
D505 Komatsu Loader	65 hours
Tandem Trucks	112.5 hours
Total machinery cost:	$2416.50
Length:	650 feet south shore
	600 feet north shore
Cost/foot:	$ 1.93
Material removed:	894 tons
Material replaced:	1836 tons
Cost/ton:	$\frac{\$2416.50}{2730 \text{ ft.}} = \$0.89$

OBSERVATIONS

1. The angled-blade dozer worked well on the mud material in lower zones of the eastern end. In the coarse sand and fine gravel, this technique was unsatisfactory. It was difficult to ascertain the reason from observations but considerable mixing of clean and contaminated material occurred. The oil depth was approximately 5" in the sand.

2. Evidence of "fresh oiling" was observed on the east to centre section of the causeway (approximately 600 feet including 350 feet recleaned by pickers) until approximately mid-June. This was the reason for delaying the removal and replacement operation.

   As usual, it was difficult to determine the actual cause; until the first week in June, observations indicated that a small amount of oil, depending on wind direction, would be carried to this area from the wreck. With increasing temperatures in June, iridescence started streaming off rocks beyond the western end. Also, iridescence was observed around the far eastern end by the fishing building. Contamination had ceased from the first source by June 20, and had decreased considerably from the second.

3. The removal and replacement operation went smoothly. Although some deep contaminated material was allowed to remain, no oil had surfaced through the clean material.

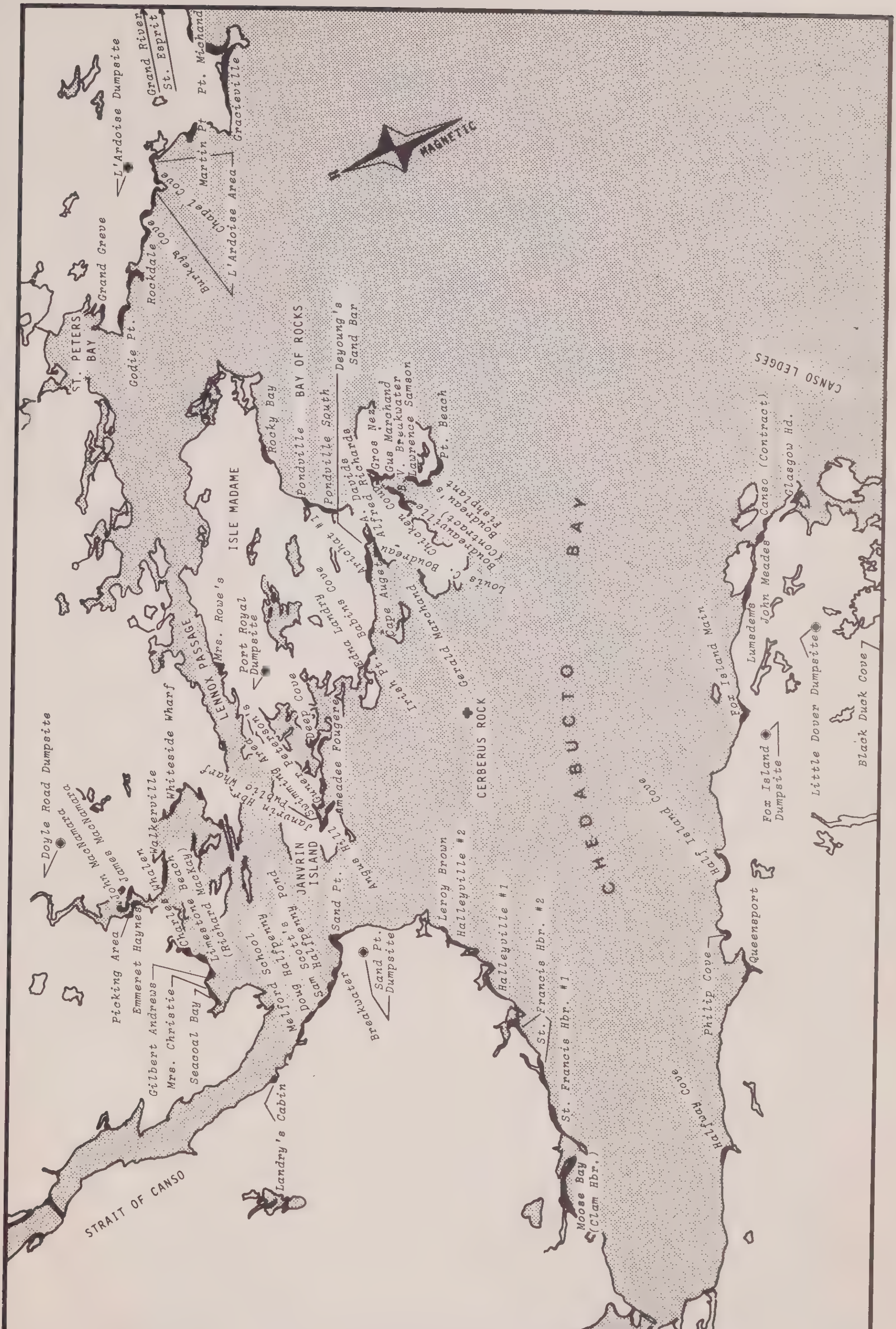
4. A section approximately 250′ long x 25′ wide containing scattered patches was observed the first week in August. This material was dry, hard and dull in appearance indicating "old oil". It was located in the eastern, upper tidal (sandy) zone. It is possible that a layer of oil was deposited during the initial stages of pollution and later covered with sediment. If this is actually what happened, it may indicate that more oil will be exposed in autumn storms.

PRESENT STATUS

The areas worked in Deep Cove remained clean until July 26 when a 900-foot section on the south was re-oiled. The re-oiling coincided with the opening of the wreck by unauthorized divers. Re-cleaning costs are estimated at approximately $2,000.00.

(Note: Re-cleaning was carried out subsequent to the writing of this section of the report)

APPENDIX 1


Doyle Road Dumpsite
John MacNamara
James MacNamara
Picking Area
Emmeret Haynes
Whalen
Gilbert Andrews
Mrs. Christie
Seacoal Bay
Charles Beach
Limestone (Richard MacKay)
Walkerville
Whiteside Wharf
LENNOX PASSAGE
Mrs. Rowe's
Port Royal Dumpsite
ISLE MADAME
ST. PETERS BAY
Godie Pt.
Grand Greve
Rockdale Cove
Burkeys Cove
Chapel Cove
L'Ardoise Dumpsite
L'Ardoise Area
Martin Pt
Gracieville
Pt. Michaud
Grand River
St. Esprit
MAGNETIC
N
BAY OF ROCKS
Rocky Bay
Pondville
Pondville South
Deyoung's Sand Bar
Davids
Richards
Gros Nez
Gus Marchand
W. Breukwater
Lawrence Samson
Pt. Beach
Arichat #1
A. Alfred Cove
Chicken
Boudreauville
Boudreau's (Contract) Fishplant
Louis C. Boudreau
Cape Auget
Gerald Marchand
Babins Cove
Edna Landry Cove
Irish Pt.
Deep Cove
Ameadee Fougere
Area's
Peterson
Swimming
Gunner
Public Wharf
Janvrin Hbr.
JANVRIN ISLAND
School
Melford Halfpenny's Pond
Doug Scott
Sam Halfpenny
Hill
Sand Pt.
Angus
Sand Pt. Dumpsite
Breakwater
Landry's Cabin
STRAIT OF CANSO
CERBERUS ROCK
CHEDABUCTO BAY
Leroy Brown
Halleyville #2
Halleyville #1
St. Francis Hbr. #2
St. Francis Hbr. #1
Moose Bay (Clam Hbr.)
Halfway Cove
Philip Cove
Queensport
Hall's Island Cove
Fox Island Dumpsite
Fox Island Main
Lumsdems
John Meades
Little Dover Dumpsite
Black Duck Cove
Canso (Contract)
Glasgow Hd.
CANSO LEDGES

VOLUME IV

APPENDIX B

OPERATION OIL

CHEDABUCTO BAY

1970

SLICK-LICKING REPORT

by

MICHAEL S. GREENHAM

Master Mariner

TABLE OF CONTENTS

Frontispiece: Slick-lickers at work in Inhabitants Bay

GENERAL

This phase of the operation had its commencement on March 12, 1970, when a prototype "slick-licker" was mounted on a 27 foot S. P. Barge. This early model had previously been sent from the Defence Research Board Establishment, Pacific, together with its inventor, R.B.H. Sewell.

Following trials of the equipment in heavy oil, (subsequently called "goop"), which were successful with the exception of a need to generally strengthen the drive system and general construction, a decision was made to have another three machines built locally under Mr. Sewell's supervision. Two of these were to be mounted on S.P. Barges and the other to be fitted to a locally made catamaran to give shallow draft capability.

The modifications to the prototype "slick-licker" were completed to schedule on the 28th of March and it was fitted to its barge for field testing at Inhabitants Bay. Unfortunately this was delayed until April 1st due to a succession of barge engine failure, broken welds on the licker and bad weather, but the end result was excellent. The machine handled "goop" very well and was able to fill one 45 gallon oil drum in a minute.

Delivery of the first production model was made on April 7th and it was mounted on a barge ready for operation on the same day. Due to stormy weather this machine did not have its trials until two days later. During these a minor design problem in the clutch mechanism developed but was rectified by the following day. The modification necessary was also applied to production models 2 and 3.

The second locally made machine had been designated a "super slick-licker" with 15 foot arms and following completion was sent to Truro for mounting on the catamaran. The complete unit arrived by road on April 16th and by evening had been successfully launched and was ready for trials the following day. These revealed several defects on the catamaran itself which were eventually remedied by April 20th. Production model number 3 was made available on the same date and mounted on an S.P. Barge. On the following day these last two units were deployed to their working areas.

OPERATIONAL CRAFT AND EQUIPMENT

Three types of water-craft were used during slick-licking work as either platforms for the machines or in a support function, and these were:

Landing craft materials, designation L.C.M.
Special purpose barges, designation S.P. Barge
Catamaran.

L.C.M.[s]

Three of these craft were in use throughout the operation although there was a changeover in the actual vessels in the early summer due to the fact that two of the original three were required for Arctic Operations aboard the C.C.G.S. NARWHAL.

These vessels have overall dimensions as follows:

Length:	50 feet
Beam:	14 feet
Light Draft:	3 feet

Available cargo capacity consists of one open well space running from the forward engine room bulkhead to the bow. This area measures 30 feet by 9 feet and has a varying depth ranging from 5 feet at the bow to 6 1/2 feet at the after end.

The bow itself consists a ramp-type door hinged at the bottom edge which can be lowered by means of a wire cable attached to a hydraulic winch. When the craft is put head on to a beach and the door lowered, easy access to the cargo area is possible for either loading or discharging. When steaming the door is secured at each side by means of a bottle-screw to relieve the cable of most of the stress and to ensure that the door does not drop accidentally.

Normally there is no means of cargo handling fitted as standard equipment as any mechanised handling required is generally done at a ship or ashore. However, slick-licking operations required that the L.C.M.[S] themselves act as mother ships to the smaller craft. In view of this, a small mast and derrick was fitted on the starboard side of each L.C.M. together with the necessary stays and guys, etc. Power for the hoist was obtained by disconnecting the end of the bow door wire from its eye bolt and attaching to the free end, the wire of the derrick hoist. Thus the hydraulic winch was able to perform two functions, although one at a time, by the mere fact of disconnecting and reconnecting a shackle according to which job the winch was required for.

The hoist system was tested to 2,500 lbs. and the normal load was limited to two full drums of recovered material, roughly a thousand pounds, but generally less. Propulsion for these twin screw craft is by means of water-cooled diesel engines of 185 horsepower, each connected to a propellor via a mechanical transmission. This gave a full speed of about 8 knots which was extremely useful.

These craft were used for other duties at times when required. In the early stages of the operation, two were personnel and fuel tenders to the salvage operation at the wreck site and were also used as pusher tugs when mooring or unmooring the "Irving Whale". Later uses included boom placing and maintenance, assistance to the Department of Public Works in some phases of their operation, and acting as a water carrier for the steam cleaning plant when the wharves and jetties were being cleaned.

As with all mechanical equipment, breakdowns occurred, but with three exceptions all were of a comparatively minor nature except in regard to lost time. The majority of the trouble was electrical, i.e., batteries, starter motors, generators etc., and sometimes necessitated flying in parts from outside the province. The exceptions were, when one engine blew a connecting rod and had to be replaced completely, the loss of a propellor, and the loss of one rudder (this was found after two months). It should however be noted that these craft were, for several months, running from dawn to dusk and sometimes beyond that, for seven days a week, and in the final analysis it can be said that they gave excellent service.

S.P. BARGES

These are the small flat-bottomed craft with a bow door normally carried aboard Canadian Coastguard vessels for lighthouse supply and inshore buoy work. The principal dimensions are:

Length:	30′ 00″
Breadth:	10′ 00″
Draft:	2′ 6″

Propulsion is by means of an air-cooled diesel engine of 45 horsepower connected to a single screw via a hydraulic transmission and clutch unit. This gives a top speed of almost 5 knots. The deck is completely plated in to form a flat working area of 18 feet by 9 feet 6 inches with a small area each side of the engine housing. With a slick-licker mounted at the bow, this working area is reduced to about 13 feet by nine feet 6 inches.

Difficulties encountered with these barges were mainly of an electrical nature as was the case with the L.C.M.s, but one barge had to be completely re-bottomed as it was impossible to repair by welding.

CATAMARAN

This twin hulled, flat keel craft was specially constructed for Operation Oil by Annand Steel of Truro and was intended to function as a shallow water slick-licker. The overall dimensions of the catamaran are:

Length:	30′ 00″
Breadth:	14′ 03″
Draft:	9″

The two hulls were joined together by means of channel and angle bars with a perforated working deck superimposed on them, except for an open section at the centre where the slick-licker was mounted.

Propulsion and steering was accomplished by means of twin 55 H.P. Chrysler outboard motors mounted one at the stern of each hull on an adjustable bracket. The two motors were connected to each other by an aluminum bar to ensure tandem movement. The actual controls consisted of a steering wheel, and a single lever gear shift/throttle for each engine situated in a control cab mounted forward on the starboard hull.

Many difficulties were associated with this craft, as follows:

1. There was little or no water flow to the propellors due to the hull section at the stern of each pontoon being of box construction. Consequently the useful power of the engines was limited as a result of cavitation. This of course was more noticeable when going astern. One remedy was to lower the engines on their mounts, but in so doing the shallow water capability was destroyed and the engines were too near the waterline. The problem was eventually solved by connecting a 10 inch deep channel bar between the stern bracket of each pontoon and mounting the two motors on this so that they were between the hulls and had a good water flow.

2. The control cabin being forward on the starboard side meant that all control cables had to be of great length and followed tortuous routes. The steering wheel cable was of the ordinary plastic covered wire type associated with pleasure boats and passed through nine lead pulleys before reaching the engines. In consequence it was not strong enough for the job and was replaced by stainless steel aircraft control cable. The single lever engine controls utilized two cables of the Bowden type, one for gear shift and the other for throttle. The required length of these was approximately thirty feet but as the maximum length available was fifteen feet, two of these had to be coupled together for each function. The result of this and the circuitous routing was an enormous amount of friction which was only overcome by the use of considerable force. On several occasions the solid rod leaders at the cable ends would bend before the inner cable would move causing a complete loss of control.

3. The cabin position did not give good all-round visibility which coupled with the control difficulties made accurate manoeuvering almost impossible. It is thought that if this control cabin had been placed at the stern, and between the hulls, most of the difficulties would have been negated as far as control is concerned and would also have given additional deck space in the working area forward.

4. The positioning of the slick-licker was amidships between the hulls which, while adequate for open water slicks is of little value when licking along a shoreline as the licker belt must then protrude in front of the craft to be effective. It is therefore essential that alternative positions be available to suit the prevailing conditions.

SEWELL OLEOVATOR OR SLICK-LICKER

This machine is basically very simple in principle, and is probably best described as being very similar to an old fashioned upright washing wringer or mangle with some alterations and additions.

On each side of the basic two roller wringer is attached, at right angles to the rollers, a hinged arm twelve feet long with freedom of movement in the vertical plane. The other extremities of these two arms are connected by a shaft passing through a non-driven roller. Running between the two main rollers and around the end roller is an endless belt made up of seven layers of canvas and a top layer of towelling sewn together. The arm assembly can be raised or lowered by means of a small hand winch to adjust the operating position with reference to the waterline. By turning the main rollers, the belt is made to travel in the appropriate direction bringing with it the oil or oiled material that is either caught up by the belt or placed thereon. This oil is then squeezed out between the two head rollers and is guided to a suitable receptacle by a sheet metal tray.

During tests with the prototype model, several deficiences came to light but all of these were of a comparatively minor nature and were easily rectified when the production models were manufactured.

1. The prototype had a main frame constructed of 1 1/2 inch steel angle bar and was not particularly rigid or well balanced. This was countered by making the frame of 2 inch channel bar and increasing the area of the base for more stability. To reduce top-weight, the drive engine was also moved down to the base instead of just below the head roller assembly.

2. The drive assembly had consisted of a four stroke, single cylinder gasoline engine of 6 1/2 horsepower connected to the rollers by means of vee belts. It was found during field tests that it was very easy for recovered oil to spill onto the vee belts and produce slippage or complete loss of drive to the slick-licking belt. It was also observed that when the recovery belt had a heavy load of "goop" on it this was sufficient to cause slippage even if the vee belts were clean. This problem was solved by utilizing motor cycle type chain and toothed sprockets on the driven roller and engine clutch. During the ensuing months of slick-licking, no further trouble was experienced other than that which is normal for machinery, i.e., clutch adjustment, renewal of drive chain, spark plug renewal and engine tuning.

3. Some difficulty was experienced in mounting the prototype on an S.P. Barge in the correct operating position due to the lack of suitable fixtures on the slick-licker. This was aggravated by the previously mentioned lack of balance. Suitable modifications were made to the production models and no further trouble occurred.

4. The arms on each side of the roller assembly could have their length adjusted within a range of about six inches to take up any stretch that the belt produced after being in use for a short while. Due to the fact that there were no graduations on the arms to facilitate getting them adjusted to the same length, some trouble was experienced with the recovery belt moving to one side and doubling over on itself. It was found that with a difference of 1/8 inches the machine could only run for two or three minutes before it became necessary to attend to the belt. This was very difficult to do once the belt was covered in bunker C and was also of course, a very dirty job. The solution was extremely simple. As each production model was made a datum mark was cut with a cold chisel.

5. The recovery belt, unless treated prior to use, would naturally tend to soak up water far more easily than oil so that it was necessary to prime it to make it olephilic. Initially, heavy motor oil was used, but it was found that while this stopped the pick-up of large quantities of water, it also acted as a lubricant and heavy bunker C "goop" tended to slide and not rise up with the belt. Accordingly, previously recovered bunker C was used for priming purposes and no further trouble ensued.

CONTAINERS FOR RECOVERED OIL AND OILED MATERIAL

It was decided that the easiest and most readily available containers were 45 gallon oil drums that had one head removed to form an open drum. A supply of large polyethylene bags was obtained and these were used as liners inside the drums. The reasons for this were twofold:

1. To prevent leaking from any possible fracture in the drum itself

2. To facilitate easy dumping of the recovered oil or oiled material, as without the liner the drum became coated in bunker C and very awkward to handle and also very messy for the crew.

Each drum had two diametrically opposite holes either cut or burnt out at the top edge so that a hook sling could be used for lifting purposes, i.e., from the deck of the S.P. Barge to the L.C.M. and from there to disposal ashore.

RECOVERY PERSONNEL

A total of 24 men was used for slick-licking work under the command of Canadian Coastguard Officers.

The disposition of these was in two main groups, men to operate the L.C.M.[s], S.P. Barges and Catamaran, and the remainder for operating and feeding the slick-licer. It should however be noted that after reaching an operating area, the craft operators would be involved in actual slick-licking activities, loading and unloading, etc., when required and not engaged in their primary function.

Each water craft had an operating crew of two men, a helmsman and engineer, which, with 3 L.C.M.[s], 3 S.P. Barges and the Catamaran accounted for 14 men. The remaining 10 were the primary slick-licker workers handling the licker and recovery containers and feeding oil or oiled material to the belt of the licker.

The slick-licker unit required a minimum of three men, one to operate the clutch and engine, one to place empty drums under the tray and remove them when full, and a third to feed the licker belt.

ORGANIZATION

Up until completion of salvage work on the wreck, slick-licking work had proceeded at low tempo due to other commitments for the L.C.M.[s], and the non-availability of production machines.

With all machines to be available in a few days, a meeting was held on April 17th to discuss the deploying of these and the necessary support arrangements.

It was decided to form two slick-licking squadrons, one for the north shore of Chedabucto Bay and one for the south shore.

Northern Squadron: To consist of the prototype machine mounted on an S.P. Barge and production model number two, (the super-licker), mounted on the catamaran, supported by one L.C.M. The area to be covered was from the east end of the Canso Causeway and thence the coastline and intervening islands to Point Michaud. A safety vessel and/or escort to be provided by the Department of Fisheries and Forestry.

Southern Squadron: To consist of production models one and two mounted on S.P. Barges supported by one L.C.M. The operating area to be from the west end of the Canso Causeway and thence the coastline and intervening islands to Louse Harbour. The safety vessel to be the Coastguard Cutter RAPID.

It was agreed that it was necessary for slick-licking operations to continue from dawn to dusk and that, to eliminate a time loss by excessive travel to the operation areas, it was desirable to accomodate the crews as near to their appropriate areas as possible. Accordingly the Northern Squadron were lodged at a motel in Arichat which was within approximately 30/40 minutes by road to the central mooring place at Inhabitants Bay. Unfortunately it was not as easy on the southern side of the Bay due to a general lack of accomodation. The best that could be found was at Guysborough which meant a lot of travel as the squadron could only tie up at Canso. (There was a boom across the Guysborough River). Each squadron was supplied with a panel truck for transportation.

The third L.C.M. was held for general duties and as a replacement should either of the other two require relief due to breakdown.

Due to the fact that it would be necessary to unload filled drums at assorted locations, and have them emptied at an approved dump site, it was agreed that Squadron Commanders were to be free to make their own arrangements with local contractors, remuneration for whose services would be at the rate set by the Provincial Machinery Rental Agreement.

For the sake of safety, it was decided that a weather limit of 20 knot winds be set, and that adequate warning be sent to the Squadron Commanders either through Canso Marine Radio to the safety vessels or by helicopter. In practice, however, operations were ceased in most cases prior to receiving warnings as the Commanders were, from experience, well aware of a coming blow.

To minimize the time spent looking for slicks, it was deemed necessary for the Department of Energy, Mines and Resources' oil observer to fly a reconnaissance at first light to locate working areas and then to inform the squadrons by dropped messages as to the situation.

GENERAL

Very little free-floating oil was encountered, and in fact was only found in six areas. The remainder of the spilled oil had, by a combination of spring and storm tides, high winds and heavy seas, been put ashore throughout the Bay and deposited on the beaches, or was mixed into seaweed or eel grass at the shoreline. The majority of slick-licking work therefore consisted of removing this oiled weed and grass.

Seaweed has little value in aiding oil recovery as it is not absorbent and is merely coated with oil on the surface, and is not generally deposited on a beach or shoreline to any great extent or quantity. On the other hand, eel grass, with its long single stalk, is an annual type of plant and in areas where it grows and subsequently dies, prodigious amounts of dead grass are deposited along the shore, to the extent that a "carpet" is formed and comes afloat at high tide. This eel grass is absorbent, and tests were run by Dr. Coupal at the University of Sherbrooke to establish the relative absorbency of a synthetic fibre received from the United States, peat moss and dead eel grass. The results showed that the oil to material ratios were:

Synthetic Fibre:	12:1
Peat Moss:	6:1
Eel grass	4.5:1

While these figures are rather conclusive on the surface, it is opinioned that out of the three, eel grass is best in practice, as the long strands act as a binding agent as well as an absorbent. Also it does not, in Chedabucto Bay at any rate, cost anything, whereas the other two do.

When dealing with oiled material such as this it is necessary for the slick-licker belt to be fed by hand, and in order to do this the men were equipped with waist-high waders in addition to the normal protective clothing. They could then stand in the shallows and, by using pitch forks which had the tines bent at 90°, guide the material onto the licker belt. To avoid clogging the head rollers it was necessary for the drum handler to assist the material on its way to the receiving drum.

SOUTHERN OPERATING AREA

This was generally free of floating oil and did not require too much attention other than the following:

Canso Harbour:

Production model number one had in fact been deployed to Canso prior to the organizing of the full-scale slick-licking operation to work in the Tickle area. As a result of the discovery of black oil leaking from the rip-rap at the head of the Government dock, (See Volume 1, page 34),work began there on the 12th of April and proved to be of great frustration as it was necessary to keep the slick-licker on standby for over a month, during which period the actual time the machine was utilized was at a minimum. Some oil was gathered every day, ranging in quantity from a minimum of half a drum to seven drums daily. To facilitate collection and prevent contamination of the rest of the Harbour, a section of T.T. boom was positioned around the head of the dock and the slick-licker operated inside this closed area.

There was no other floating oil or oiled material in Canso Harbour, as this had been protected after the wreck by a boom across False Passage and the dam across the Tickle.

CANSO TICKLE:

This area had been very heavily contaminated, in some places to a depth of 6 inches and more. Production model number two commenced work here on April 21st, taking over what was left undone when it became necessary to move the other licker to Canso Harbour. Production model number one had worked here for several days prior to the discovery of the Harbour oil.

The heaviest concentration of oil and oiled weed was found on the western side of the Government wharf and approximately 35 drums were recovered in all from here. Ten drums of oiled weed were collected from the northern and southern sides of the Tickle, but unfortunately, a lot on the northern side could not be reached due to the water depth being only a few inches at high tide and the presence of underwater obstacles.

By the evening of April 22nd the whole of the southern shore had been subjected to a detailed reconnaissance by helicopter and barge and was found to be free of any contamination that could be handled by the slick-licker, except of course for the leakage at Canso Harbour which had not been rectified.

The one available licker and the L.C.M. of the Southern Squadron were therefore deployed to the north side of Chedabucto Bay to assist the Northern Squadron.

NORTHERN OPERATING AREA

The Northern Squadron had commenced their working in the Inhabitants Bay area and by the time the Southern Squadron moved over to the north shore no other area had been touched by slick-lickers. The South Squadron therefore commenced working westward from the Petit de Grat outer shore on the morning of April 24th and by evening had moved around the coastline to Arichat Harbour without finding anything that could be licked up. On the following day they proceeded westward again and finally found some floating oil and contaminated weed at Janvrin Island. There was not a great deal of oil and weed in any one place, but rather a sparse intermittent line stretching from the general area of the Harbour around the coast to the west. Two days were spent collecting this as it was encountered, and a total of 27 drums were filled.

By April 30th both sides of Lennox Passage had been covered, the recovery from this area being a total of 8 drums, and during the afternoon of that day the two squadrons joined forces to work in Inhabitants Bay and the surrounding islands. This was then the only area left in Chedabucto Bay with appreciable floating oil and oiled material.

INHABITANTS BAY:

At the time of the wreck of the "ARROW" this area was for the most part iced over, and remained so to a lesser degree until the second week in April, although at the end of March the only places still appreciably affected were the eastern halves of Inhabitants Harbour and The Basin. When slick-licking operations commenced here it was not apparent that large quantities of oil had entered the area, and in fact when tests were made on the prototype machine some time and difficulty was experienced in finding a spot to conduct the tests. With this in mind, completely wrong estimates were made as to the amount of time necessary to clean up Inhabitants Bay.

After all the ice had gone, however, the situation was changed from a minor clean up job to a full-scale operation that would utilize all the available machines for a considerable time.

The whole of The Basin and the southeastern portion of Inhabitants Harbour was an area of vigorous growth for eel grass. At low water, particularly during neap tides, the appearance was that of a well-planted lawn. Over the years this eel grass had died and been washed up along the shores until it formed a thick carpet extending from the high water spring and/or storm tide mark to the low water mark. The formation of ice during the winter would not affect this structure as it was of course permeable to water, and when this froze the grass was merely frozen in and subsequently thawed out to its original state during the spring break up or melt.

It is now thought that at the time of the original spill, large quantities of oil had entered into Inhabitants Bay and been driven under the ice cover by the general water movement in the area. This oil had then been moved to the shorelines where it remained as pure oil until such time as the melt began. It then started to soak into, and between, the dead eel grass stalks as these came free of the ice. This process started at the bottom of a layer of dead grass, which could be anything up to 12 inches thick, and was not apparent to either aerial or surface observation. When the mechanism was complete and all the ice had gone it only remained to be discovered at one location to bring about a complete new appraisal of the area.

This discovery was made in a cove situated at the eastern end of The Basin, Area A on chartlet. (See Appendix 2). The area in question was extremely shallow and could only be entered by the slick-lickers about one hour before and after high water, the limitation of course being their loaded draft when coming out. During the first three high tides, a total of 124 drums of heavily oiled eel grass was recovered from this area without any trouble. On successive tides lesser amounts were recovered until after a week the cove was as free of oiled grass as possible. Some pure oil had soaked into the actual beach between the rocks, stones etc., but could not be removed by slick-licking as it would not float off the beach at this time. As this did not present a source of immediate danger as far as movement was concerned, the area was put aside for more attention later.

With the concept of this new form of contamination, the parts of the day other than high water had been utilized by having two units operating independently, one to carry on collecting oil and contaminated material that lay in small quantities along the shore at places not affected by tidal considerations, and the other to find areas similar to Area A.

This was at first hampered to some degree by the number of mud bars and shallow areas around the shoreline which made large detours necessary with a consequent loss of time. Eventually, however, navigable channels were discovered and marked by makeshift spar buoys to the extent that even loaded L.C.M.[8], could be conned through without difficulty at about half tide.

An open beach area to the north of Area A was discovered next, and was named Greenham's Beach by the scientific members of the Task Force. This area was of great interest to the team's scientists as it proved to be completely unlike any other area found in the whole of Inhabitants Bay. There were large expanses of heavily contaminated eel grass, other areas that had a thick covering of pure oil that came afloat at high water, some in which it did not, and the odd place where there was no contamination at all. A personal theory for the latter is that since this whole area is shallow the winter ice cover had become solid from the water level to the ground in the extreme shallow parts and thereby prevented the oil under the Bay ice from moving in.

Following recovery of the free floating oil and contaminated eel grass, a field experiment was performed on an area where the oil did not rise with the tide. This consisted of placing and trampling into the oil in adjacent areas measuring 20 by 10 feet, three different absorbent materials. These were dry straw, peat moss and clean, dry eel grass. After a period of two days the area was revisited by the slick-lickers at high tide to assess the results.

In the case of the peat moss nothing had happened and it was still under water and inaccessible. The eel grass had soaked up oil, floated and was successfully recovered. The strawed area was something of a mystery as there was nothing left on site other than oil still stuck to the mud! The straw was eventually found on the northern side of the Bay on a previously clean beach and was not oiled to an appreciable degree other than a surface coating.

As time progressed the whole Bay was subjected to the close attention of the slick-lickers and several other areas of heavy contamination were found. None of these had the same characteristics as Greenham's Beach, but were very much the same as Area A. These are designated on the chart as Areas B, C, D and E. Shorelines that were cleared of lesser amounts of contaminated material are shown on the chart.

The water circulation in the Inhabitants Bay is, generally speaking, unknown, but it is probable that the flow coming from Chedabucto Bay follows the western side of Evans Island and then splits into two streams, one passing between Freeman Island and Round Island into The Basin and the other following the northern shore of Freeman Island into Inhabitants Harbour. This probable circulation seems valid in view of where the heaviest pollution was found. One peculiarity, however, concerned Areas A and C where it became apparent that there was a dumb-bell effect, with oiled material moving to and fro between the two. No logical explanation could be found as this movement was observed at various stages of tide and was not necessarily in the expected direction.

RE-OILING

The occurence of re-oiling was noticed towards the end of May but this in itself did not present too much of a problem for the slick-lickers as they were continually on the move from area to area on a cyclic basis so that over a period of about ten to twelve days, all areas would be revisited and oil and contaminated material removed as it became available. Without doubt, the heat of summer was causing leaching of oil from the beaches and this was circulating in the form of iridescence; this was countered by the amount of newly dead eel grass entering the circulation and collecting the oil for subsequent deposit along the shoreline.

Attempts were made to consolidate the iridescence into pure oil by using fish nets and boom sections, but this did not succeed, and it was impossible to collect iridescence via the slick-licker without an excessive amount of water. One estimate was that when attempting to do this, the amount of oil collected was much less than one per cent.

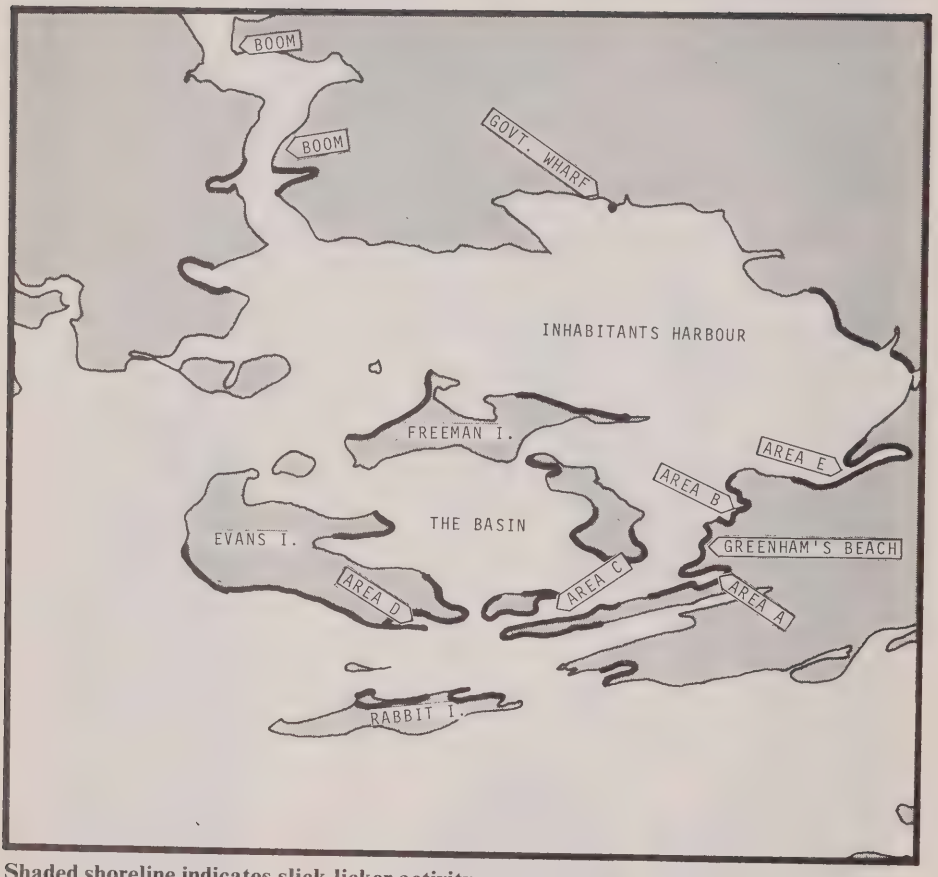
Slick-licking work continued in the Inhabitants Bay area until August 1st, by which date it was apparent that there was no further oil or oiled material that could be recovered by this method. An amount of oil was still stuck fast onto the shore in some places and unrecoverable, but efforts to collect this will be made subsequent to the re-pump of the stern section of the wreck in September. It is not anticipated that this will be too difficult as by that time all the annual crop of eel grass will have died and been eventually cast ashore so that a repetition of the previous situation will occur.

APPENDIX 1

CHEDABUCTO BAY

NOTE: For place names see Appendix A (Appendix 2)

APPENDIX 2



Shaded shoreline indicates slick-licker activity.

INHABITANTS BAY

APPENDIX 3

RESULTS OF SLICK-LICKING ACTIVITIES

It is difficult to provide truly accurate figures of the amount of oil recovered by slick-licking activities because of the varying nature of the recovered material. For the purpose of this report the following was taken into account when determining the statistical figures.

1. A daily count of the number of drums filled had been kept, and the general nature of the recovered material noted.

2. Due to the fact that the 45 gallon drums used as containers were open at one end and had lifting holes at the top edge they could not be filled to capacity when dealing with "pure" oil, and when dealing with oiled eel-grass etc. even overfilling of the drum would result in less than total capacity due to a compacting of the material after a short while. Accordingly, one drum has been considered to hold a maximum of 40 gallons of either oil or oiled material.

3. To estimate the amount of actual oil recovered in a drum an arbitrary factor has been used. In cases where there was an absence of other material in the recovered oil this factor is 1.0, and in the case of contaminated weed and eel-grass the factor varies from 0.5 to 0.8. The choosing of these was based on personal observation of the recovered material and care was taken to ensure that these were realistic. The following statistics should therefore be read with the above considerations in mind, and note should also be taken of the fact that in these calculations no effort has been made to introduce the water-emulsion factor which would be present regardless of whether the oil recovered was "pure" or mixed with absorbent material.

Location	No. of Drums Recovered	Appx. Gals. Material	Factor	Appx. Gals. Oil
Canso Tickle	45	1,800	0.8	1,440
Canso Hbr. (Shore spill)	75	3,000	1.0	3,000
Sub Total	120	4,800	-	4,440
Janvrin Is.	27	1,080	0.5	540
Lennox Passage	8	320	0.6	192
Inhabitants "A"	650	26,000	0.7	18,200
Inhabitants "B"	456	18,240	0.7	12,768
Inhabitants "C"	590	23,600	0.7	16,520
Inhabitants "D"	610	24,400	0.7	17,080
Inhabitants "E"	200	8,000	0.7	5,600
Greenham's Beach	932	37,280	0.8	29,824
General Shore Inhabitants Bay	1,938	77,520	0.6	46,512
Sub Total	5,411	216,440	-	147,236
GRAND TOTAL	5,531	221,240	-	151,676

ACKNOWLEDGEMENTS

First to Dr. P.D. MacTaggart-Cowan, Dr. H. Sheffer and Captain M.A. Martin, R.C.N. who were available for consultation if required no matter whether it was day or night.

To the men of the slick-licker crews who were called upon to perform tasks that were dirty, arduous and sometimes frustrating under all extremes of weather. They formed a wonderful crew and I thank them.

To my colleagues on the Task Force, and in particular the Officers of the Department of Fisheries and Forestry, who co-operated so splendidly when required.

To all the local people and business houses who responded to our needs in such a positive manner without regard for the hour or normal practice.

VOLUME IV

APPENDIX C

OPERATION OIL – S.T. "ARROW"

CHEDABUCTO BAY

1971

SLICK-LICKING REPORT

by

MICHAEL S. GREENHAM

Master Mariner

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INTRODUCTION

1. Slick-licking operations in the Inhabitants Bay area of Chedabucto Bay had been terminated in the fall of 1970 shortly after completion of "Operation Scour", the second pump-out of oil from the sunken stern section of the "Arrow". This was for two reasons:

(a) There was not any free floating recoverable oil anywhere in Chedabucto Bay, other than streams of iridescence from the wreck and some of the contaminated rocky areas which could not be recovered.

(b) The carpet of dead eel-grass on the shorelines of Inhabitants Bay that had absorbed and adsorbed floating oil had all been picked up and the thin residual oil film that was stuck fast onto the rocks and on the shingle areas of the beaches had begun to stabilize and could not be removed by other means.

2. It was recognized however that there would in all probability be a need to resume slick-licking activities during the early summer of 1971 to recover the new deposits of dead eel grass that would be cast ashore during the coming winter and become contaminated by oil.

3. A survey of Chedabucto Bay was conducted by members of the Task Force on March 23rd and 24th, 1971, by helicopter and on foot to determine what measures were needed to further reduce the ecological damage to the area. It was found that there would be a need both for a program of further beach cleaning at some areas by the Department of Public Works, and for a relatively small scale slick-licking operation compared to that needed during the 1970 operations in the Inhabitants Bay area.

4. Responsibility for this undertaking was placed with M.S. Greenham of the Ministry of Transport, the Officer in charge of the previous slick-licking operation. He would be supported by a nucleus of other experienced Ministry personnel to run and maintain the equipment and by locally engaged men to form the crews. The operation would be scheduled to commence in May 1971 so the inherent dangers of oil in circulation could be minimized prior to the commencement of the tourist season.

LOGISTICS

1. The equipment to be used was virtually the same as that for the previous year but on a smaller scale and consisted of:

(a) One fifty foot twin screw L.C.M. (Number 49) in which to transport filled drums ashore. This craft was already at the Canso Lock since it had been utilized during the construction of additional aids to navigation in the area. It did not however have a boom such as had been fitted to the L.C.M.'s used during 1970 so it was necessary to have this fitted at the local shipyard. To do this was far more economical than transporting one of the already equipped craft lying at the Marine Base in Dartmouth.

(b) One thirty foot S.P. Barge fitted with the Sewell Slick-Licker that had been used during 1970 and could be easily transported by road on a low-bed.

(c) One thirty foot Catamaran fitted with the Sewell Slick-Licker. This was one of two new oil recovery craft that had been built for the Ministry of Transport in March of 1971 to an improved design based on the unit built for Operation Oil. The propulsion for these craft was by twin water-jet pumps driven by air-cooled Volkswagon engines and this gave them great manoeuvering capabilities, although in weeded shallow areas with less than four feet of water the systems would become clogged with weed very quickly with a resultant loss of power which rendered them ineffective.

(d) One stake truck fitted with a 4-ton capacity hydraulic crane. During the previous operation it had been necessary to use a front end loader to transfer filled drums from the dock to hired trucks for dumping and this had proved very costly. Accordingly this crane-truck was obtained on contract from Calfax Ltd. of Dartmouth and proved invaluable. With this it was possible to unload directly from the L.C.M. to the truck bed and it could also be used for many other aspects of the work that required a lifting process such as fuel drum handling, engine changing, etc.

(e) Ancillary equipment consisted of various hand tools such as rakes, shovels, pitchforks, etc., empty 45-gallon open-ended drums for use as containers, polyethylene drum liners, ropes, slings, etc. Most of this was obtained either from the Dartmouth Marine Base or the stockpile at the Canso Canal.

2. The Ministry of Transport personnel involved consisted of the Officer in charge and four others. Two of the latter also had previous experience in the work to be performed. The eleven men to form the crews were to be hired as term labourers and particulars of the duties involved, qualifications required, rates of pay, etc., were communicated to the Canada Manpower Centre at Port Hawkesbury for local advertisement. Following the initial screening of all applications, a total of 22 qualified men were interviewed and rated for the positions by a board convened under Public Service Commission regulations. The top eleven candidates were offered employment, but at the commencement of operations one man declined the position which was then awarded to the next rated candidate.

3. By agreement with Calfax Ltd. the truck-crane operator performed other duties when not required for his primary function, so for all operational purposes a total of 17 persons, including the O.I.C., were involved.

OPERATIONS

1. On Monday, May 17th, 1971, the two slick-licker vehicles were loaded onto low-bed trailers, some of the ancillary equipment loaded onto the crane-truck, and this and the Ministry of Transport personnel proceeded to Port Hawkesbury to set up an advance base at the Canso Canal site. On arrival the two craft were put in the water and secured along-side pending their proceeding to the operational area. During the next three days the Dartmouth personnel carried out waterborne testing of the equipment, the gathering together of other needed items at the Canso Canal for storage aboard the L.C.M. when the necessary modifications had been completed and it could be collected from the shipyard, and the stockpiling of fuel, lubricants and other expendable items. During this period the O.I.C. also conducted the necessary procedures for hiring the local men to form the crews, and made final arrangements with the Municipality of Richmond County for the disposition of the recovered oil and oiled material to the dumpsite at Port Royal. This had previously been one of the approved dumps for Operation Oil, but on completion of the 1970 activities overburden had been placed on top of the contaminated material and the site had been taken over and expanded as a municipal dump for the use of the local residents.

2. By Friday, May 21st, all necessary arrangements had been made and the watercraft, loaded with ancillary equipment, were steamed to the operational base at the Whiteside government wharf in Inhabitants Bay. During that weekend a comprehensive waterborne survey of the whole area confirmed those areas in which it would be necessary to operate and, in general, these were the same areas that had been found most prone to contamination during 1970.

The additional areas in which contaminated material was found were concentrated mainly in Lennox Passage. The southeast side of Rabbit Island, the northern shore of the passage opposite Fish Shoal, and the small inlet between Low Point and Rock Point were all contaminated. On the southern side of the passage, contaminated material had been pushed into the inlet at Glasgow Point, either by the tide or by winter ice. Since Lennox Passage had not been appreciably affected the previous year (only eight drums of oiled material recovered), it is apparent that the decision to leave the dams in place at the head of the passage throughout the winter was justified.

3. On Monday, May 24th, the crews reported for duty at Whiteside and clean-up operations began once more. The locally engaged men were trained on the methods of operation, formed into two work crews and, despite their lack of experience in this unique work, they were, after a day or two, carrying out their dirty, arduous task with an enthusiasm which carried through to the end.

4. The pattern and methods of operations followed that of the preceding year during which, due to tidal considerations, the various areas were visited on a rotational basis and oiled material recovered until the falling tide forced retreat to another location. Occasionally it was necessary to stop the recovery work altogether and at such times the crews were landed as near as possible to an area and would then proceed on foot to stockpile material for subsequent recovery.

5. The quantity of material and the amount of oil that it contained was, as expected, considerably less than the previous year's total. Since there had not been a release of oil from the wreck, other than a fairly regular stream of very light iridescence from the residual oil trapped and unrecoverable in the superstructure of the stern section which almost always curved towards Cape Auget and then out to sea, it is probable that the oil deposited along the shorelines of the Inhabitants Bay area was leaching off as a result of water action, entering the water column in particulate form and as iridescence and being carried by the general circulation for subsequent deposit at other locations where it would coalesce as black oil once again.

6. Evidence was found on the north shore of Evans Island that oil stuck to the rocks above the high water mark, and previously stabilized was, after two days of extremely sunny weather (daily maximum 70 degrees F), beginning to run down the rocks and beach to the inter-tidal zone. This area was treated with powdered limestone in an attempt to re-stabilize the oil, and on completion of total activities this appeared to have been accomplished. It is apparent however that there is a need for more research into the factors affecting the stabilization of an oil film and its subsequent destruction by biodegradation and that this research should be conducted on an urgent basis.

7. During the course of our operations there was a spill of Bunker C at the Point Tupper Refinery of approximately 250 barrels due to a fractured spool piece aboard a tanker that was loading at the terminal. The refinery staff had managed to enclose the spill by booming but unfortunately they then suffered a mechanical breakdown in their recovery equipment. Since our catamaran slick-licker was not at that time in use because of its susceptibility to clogging of the jet intakes by weed in the shallow waters of Inhabitants Bay this was steamed to the refinery where it performed admirably in all respects. This was the first occasion in which the recovery unit had operated in the originally intended field conditions, a free floating oil slick that was not contaminated by extraneous material, and there was no difficulty in picking up the oil. The difficulty that was very apparent was in disposal of the filled containers, which took about three times as long as it did to fill them. For the successful licking of a large oil slick it is essential that there be either containers that could be filled, sealed off and dumped back into the water for recovery by another vessel or other means, or flexible rubber dracones with a large capacity that can be filled direct from the slick-licker discharge.

8. By Thursday, June 24th, there was no more recoverable oiled material in either the Inhabitants Bay or Lennox Passage areas and the craft and equipment were cleaned off and steamed back to the Canso Canal to be ready for shipment back to Dartmouth the following day.

9. Statistics of the amount recovered from the various areas had been maintained and these are tabulated in Appendix 2 to this report. The general procedures used to obtain final figures of the amount of actual oil recovered are those outlined in Appendix C of the 1970 report. It must be emphasized again however that, apart from the number of drums of oiled material actually recovered, the figures concerning oil content are obtained by personal interpretation and have no other justification.

CONCLUSIONS

1. It is doubtful that any more cleaning of Chedabucto Bay will need to be carried out by the slick-lickers. The small amounts of oil film still left on the rocks and shingled areas should not cause any problem and are best left to the natural cleaning process.

2. In the areas of Inhabitants Bay, Lennox Passage and the surrounding islands there is once more an abundance of both bird and fish life. During our operations this year, a school of porpoises grounded at MacNamaras Cove whilst chasing a school of fish and had to be rescued, placed aboard the L.C.M. and taken to deep water for release although, unfortunately, we could not save them all. Blue herons, cormorants, black ducks and a few bald eagles were all seen as well as large numbers of the smaller birds. No dead or contaminated birds were found.

3. During the course of operations there were no complaints received from the local fishermen as to contamination of their gear and there did not appear to be any damage to the lobster fishery. Herring seiners have also worked close to the wreck without adverse affect to either their gear or catch.

4. The slick-licker has now become one of the accepted tools to be used in the clean-up procedures following an oil spill and is now in use by both government and industry. It has been developed and re-engineered to be much superior to the prototype that first appeared at Chedabucto Bay in March of 1970; there are limitations to its use, but there also additional uses. It was never intended for the use to which it was put during the "Arrow" clean-up but it worked, and without it we could not have recovered 169,764 gallons of the spilled oil by any other means.

Appendix 1


APPENDIX 1
INHABITANTS BAY AND
LENNOX PASSAGE AREA
(EXTRACT OF CHART 4308)
SHORELINE INDICATES AREAS
WORKED BY SLICK-LICKERS.
GOVT. WHARF
INHABITANTS
HARBOUR
FREEMAN ISLAND
THE BASIN
EVANS ISLAND
INHABITANTS
BAY
RABBIT ISLAND
AREA E
AREA B
GREENHAMS BEACH
AREA C
AREA A
AREA D
AREA F
AREA H
AREA G
AREA I
DAMS
JANVRIN ISLAND

Appendix 2

STATISTICAL RECOVERY TOTALS

Location	No. of Drums filled	Appx. Galls. Material	Appx. Oil Content Factor	Appx. Galls. Oil
Inhabitants A	260	10400	0.3	3120
Inhabitants B	205	8200	0.2	1640
Inhabitants C	220	8800	0.15	1320
Inhabitants D	210	8400	0.2	1680
Inhabitants E	245	9800	0.3	2940
Greenhams Beach	272	10880	0.2	2176
Lennox Pass. F	210	8400	0.2	1680
Lennox Pass. G	155	6200	0.2	1240
Lennox Pass. H	90	3600	0.2	720
Lennox Pass. I	120	4800	0.1	480
Misc. Shoreline	546	21840	0.05	1092
—	2533	101320	—	18088

VOLUME IV

APPENDIX D

OPERATION OIL

CHEDABUCTO BAY

1970

OPERATION SCOUR

REPORT ON THE RE-PUMP OF THE SUNKEN TANKER "ARROW"

by

MICHAEL S. GREENHAM

MASTER MARINER

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GENERAL

Following completion of oil salvage operations on the stern section of the "ARROW" wreck in April 1970, it became apparent towards the end of May that there was a substantial re-oiling of beaches in Chedabucto Bay due to the leaking of oil from the wreck. In order to stop this re-contamination, a team from the Fleet Diving Unit (Atlantic), returned to the area on May 29th and carried out re-sealing procedures.

On completion of these, it was established how much oil remained in the tanks by firing a succession of cox gun bolts through the hull at each tank location so that the oil level could be ascertained. This task required a great deal of effort from the diving team due to the thickness of the hull plating requiring several shots to achieve penetration for each test hole. This procedure could, of course, only be utilized for the wing tanks, and established the following results:

Tank No.	Port	Centre	Starboard
6	M.T. (Open)	M.T. (Open)	2′6″
7	M.T.	?	M.T.
8	9′8″	?	5′6″
9	M.T.	?	M.T.
10	23′0″	M.T. (Open)	M.T.

These soundings indicated a residue of about 400 tons of oil still in the wreck. Unfortunately there was no method of sounding the centre tanks available at that time, but it was decided that in all probability there would be some oil contained in these tanks.

The residual oil in the stern section arose from three sets of circumstances:

1. Errors in judgement at the time of the original pump-out were made in respect of tanks 8 port and 10 port.

2. As a result of the extreme cold temperature prevailing during the initial salvage operation (0°C), a thick layer of oil had stuck to the sides of the tanks and, with higher temperatures, was now rising in the tanks.

3. The high viscosity of cold oil had caused considerable cavitation at the final stage of pumping.

It was considered that there were available four options regarding the final action to be taken with the stern section.

These were:

a. Seal the wreck as tight as possible and leave it.

b. Resume salvage operations to recover the residual oil and then seal the wreck.

c. Demolish the wreck by the use of explosives.

d. Raise the wreck and then either beach it for salvage or sink it beyond the Continental Shelf.

It was not recommended that option (a) be approved because the quantity of oil remaining in the tanks would in all probability seep out for years to come, and the whole stern section might possibly disintegrate during a severe storm causing major re-contamination of the area.

Option (c) was not recommended because demolition would release all the residual oil at one time and the chances of containing this until surface recovery was completed were remote.

Option (d) was not recommended because of the cost. This job would be extremely difficult as the removal of the funnel at an earlier date had opened up the whole engine room top, and precluded use of the engine space for buoyancy. To restore its integrity would be a major project in itself.

It was recommended that option (b) be approved with the oil to be recovered by another pumping operation, using the same techniques as before, during September when temperatures would be at their maximum (10°C). This would be a combined operation between the Department of National Defence (Maritime Command) and the Ministry of Transport.

The proposed organization for the operation was to consist of Maritime Command providing:

1. The Salvage Master, Lt. Cmdr. D.B. Hope, R.C.N.

2. A Navy Diving Team and Diving Tender.

3. Other forces as found necessary

and the Ministry of Transport providing:

1. Deputy Salvage Master/Operations Officer, M.S. Greenham, C.C.G.

2. L.C.M.s, slick lickers, etc.

3. Equipment – hoses, gate valves, etc.

4. Other forces as found necessary.

The recovery vessel would be the S. T. "IMPERIAL CORNWALL" chartered from Imperial Oil Limited as had been previously done to pump out the "IRVING WHALE".

Ministerial approval for this course of action was received on June 30th and from that date on plans were made to carry out the operation. By Maritime Command Planning Directive 7/70 dated August 3, 1970, the proceedings were designated "Operation Scour".

PLANNING

1. On completion of the first pump the equipment used had been put into store at either the Canso Canal or the Marine Base at Dartmouth, and the first consideration for Operation Scour was to prepare a listing of all the equipment required and to ascertain if this was in good order.

An examination of the previously used 8" suction hose indicated that of the fifteen lengths available only one was in reasonable condition, the others being either crushed to some degree or having broken reinforcement wires. It was decided therefore to order ten new lengths, each of 6" inside diameter and 25 feet long. This would be assembled into two lengths of 125 feet for salvage purposes. The smaller diameter and consequent weight loss would ease the work of the divers considerably. With the exception of four 90° elbows, all the other equipment required was found to be available in good order and no further purchases were made.

2. The receiving vessel "IMPERIAL CORNWALL" was visited during the early part of August with a view to examining available facilities and discussing with her Master and Officers the general requirements of the operation, and the arrangements that had to be made to meet these. From this discussion there were only three points that emerged as problematical:

(a) She is an old vessel (built 1927), rather slow, and could nôt safely make the voyage from Halifax to Chedabucto Bay except in ballast. As her normal activity is the carriage of bunker oil this ballast would be extremely dirty and could not be disposed of at Chedabucto Bay. This situation was remedied by Imperial Oil Limited arranging a cargo of bunker to Point Tupper in the Canso Strait and from there the "IMPERIAL CORNWALL" could proceed downstream to the wreck site in a light condition without danger.

(b) The suction/delivery manifold, situated at the break of the forecastle, has only two connections, one of which has been maintained as a "clean oil" line. It was decided that only the "dirty" line would be used because the quantity of Bunker C to recover was comparatively small, and frequent shifting of the hose from tank to tank would be required. This could be covered by alternating two hoses; while one was on the manifold the other could be rigged on another tank ready for pumping.

(c) "IMPERIAL CORNWALL" has a limited fresh-water capacity, and considerable quantities of steam would be required both for the pump and steam trace as well as her ordinary ship's services. Accordingly a non-powered water barge, YSW 219, was obtained from the Queen's Harbour Master in Halifax. This was to be towed from the water source at Mulgrave to the "IMPERIAL CORNWALL" about every second day by a local tug contractor.

3. Considerable attention was paid with regard to providing adequate moorings for the receiving vessel. Arrangements were concluded to have four moorings made up by the H.M.C. Dockyard Boatswain, each consisting of 600 feet of 1 1/2 inch studded link chain and a 3 ton stockless anchor. The mooring buoys attached to the ends were 5 foot can buoys obtained from the Dartmouth Marine Base. From the top of each mooring chain a pendant of 1 1/2" open link chain was brought up and temporarily lashed to the ring on the top of the buoy. During the first salvage operation the rope mooring lines had been shackled to these chain pendants and some difficulties had occurred in mooring and unmooring, particularly in poor weather. Accordingly hard eyes were spliced into one end of the polypropylene mooring lines and senhouse slips fitted which allowed instant release if necessary.

An analysis of weather conditions for previous years indicated that the predominant wind direction during September was from the northwest and the "IMPERIAL CORNWALL" was therefore moored head on to this direction. (See Appendix 2 and 3 – Mooring Configuration).

These moorings were to be laid by a Canadian Coastguard vessel at the positions marked by floats placed by the salvage team.

4. **Centre Tank Gauging**

As previously recounted it was not possible, at the time of the survey in early June, to ascertain the contents of the centre tanks of the "ARROW" wreck because of the lack of a suitable measuring device. To combat this deficiency a meeting was held at the Defence Research Establishment Atlantic on July 9th, 1970, and it was decided that a suggestion to measure pressure differences merited investigation and development.

The specific gravity difference between sea water and "ARROW" Bunker C would be about 0.062 gm/cc at 60°F, (the expected water temperature during September), and this difference should yield a pressure of 0.027 lb/sq. inch or 0.71 inches of water for each foot of oil in a particular tank. Calculations showed that one foot of oil in a centre tank would correspond to approximately 182 barrels. Provided that these measurements could be made, it appeared that the answer to the question was a matter of simple mathematics.

To make a suitable instrument a "Magnehelic" gauge was obtained which, although designed to measure low differential air pressure, (the range being from 0 to 25 inches of water), could be waterproofed by filling the case with alcohol with no adverse effects. Three of these gauges were fitted with the necessary plumbing to attach them to a cox gun air-bolt, and were available in September for the re-commencement of pumping operations. (Appendix 4)

Three simple manometers were also made up, each consisting of an inverted loop of plastic tube secured to a backing plate together with fitting attachments. With these it was necessary to actually measure the difference in levels but the mathematics were the same.

Neither of these instruments gave an accurate reading in the final analysis, it being thought that on site there was too much surge in the water which caused pulsations in the readings and consequent inaccuracy. The Magnehelic gauge was particularly susceptible to this surging, but it is considered that if a means could be found of dampening down the instrument and simplifying the operating procedure, it will be of value on future occasions.

5. The operating vessel for the divers involved would be the diving tender, YMT 11, from the Fleet Diving Unit (Atlantic) and would carry eight divers and additional operating personnel.

Arrangements were also made to have three L.C.M.s available for use in assisting the "Cornwall" into the moor and also to provide facilities for the transfer of personnel and stores to and from shore. The crews for these consisted of the re-assembled slick-licking contingent, (reduced to 14 men), and those not operating the L.C.M. would be used as deck workers aboard the diving tender and "IMPERIAL CORNWALL". One L.C.M. was detached during the operation and went to Summerside, P.E.I. for Operation Whale.

3. OPERATIONS

A schedule of events had been prepared for the operation (Appendix 5). With few exceptions, this was followed.

The first activity required was to remove blanking plates and fit gate valves onto the flanges fastened to the deck of the "ARROW", and by the evening of August 31st, this had been done on tanks,

6 starboard

7 centre

8 port and starboard

10 starboard.

On the following day an attempt to drill into tank 10 port was made with the hot-tap machine, but only the pilot drill penetrated and it was presumed that the machine had been situated over a longitudinal girder underneath the deck plating. In order to attach the measuring gauges, air bolts were fired from the cox gun into 8 centre but the ammunition proved to be too heavy and complete penetration occurred; this, therefore, had to be postponed until lighter ammunition was obtained.

The weather deteriorated on the 2nd of September and there were WSW winds of 30/40 knots and 4 foot seas at the wreck site. Despite this the flange from 10 centre was removed and placed onto another location at 10 port in readiness for another attempt to penetrate the tank. The marker floats for the mooring ground tackle positions were laid out during the afternoon using horizontal sextant angles, and a stadimeter for distances, in preparation for the arrival of the CCGS SIR WILLIAM ALEXANDER which was to lay the moorings the next day. This went off without any difficulty, the procedure being for the ship to drop the mooring on the marker and then stretch the chain towards the wreck by sighting on the diving tender, which was moored directly above the sunken stern of the "ARROW". When the chain came tight the buoy was released. On completion of this, diving activities were resumed, air bolts were fired into the centre tanks and the measuring gauges attached. The hot-tap drill was attached to the new flange on tank 10 port and a further attempt at penetration made. Unfortunately the drill spindle fractured shortly after starting and it was found impossible to make repairs aboard the tender.

The gauges were read after a short waiting period and the results were as follows:

Tank	Gauge Type	Reading	Bbls of Oil
7C	Manometer	1/4"	65
8C	Manometer	3/4"	182
9C	Magnehelic	2-4" pulsating	782 Average

The next day, 4th September, the readings had altered and were:

Tank	Reading	Bbls of Oil
7C	1"	250
8C	1 1/8"	260
9C	3-4" pulsating	790 Average

These readings and quantities were noted, but were subsequently shown to have little value when the tanks in question were pumped out. All the Magnehelic gauges were tried out to ensure that the fluctuating readings were not caused by instrument error.

On this same day, drilling was resumed on tank 10 port with the hot-tap, but the drill unaccountably kept stalling and penetration did not occur.

During the forenoon of September 5th, the hot-tap drill was stripped down, cleaned, re-assembled and the cutter sharpened for yet another attempt on tank 10 port. Drilling was resumed in the early afternoon and after an hour and a quarter, penetration was made. When the drill was recovered it was found that the coupon cut out from the tank top was 1 1/8" thick. In all probability this thickness had been a major reason for the drilling problems.

All was now in readiness at the wreck site for the commencement of pumping operations.

In the meantime the equipment that was to be used aboard the "IMPERIAL CORNWALL" had been assembled on the jetty at Shearwater, the Naval Air Base in Dartmouth, so that this could be loaded aboard the tanker prior to her departure for Chedabucto Bay. Unfortunately the ten new lengths of suction hose were not available at this time so these were subsequently shipped by road to Arichat, loaded into an L.C.M., which then transferred them to the "IMPERIAL CORNWALL". These hoses could not be obtained ex-stock and it was necessary to have them specially manufactured in the U.S.A.

Having discharged her cargo at Point Tupper, the "IMPERIAL CORNWALL" was on site and ready for mooring on the 8th September, but the weather was too rough and presented some danger of the tanker being blown onto the superstructure of the wreck. The wind was from the SE at 30/35 knots with 4 — 5 foot seas, and although there was a clear depth over the wreck of about 12 feet in calm weather at low water this was of course reduced as a result of wave height. In consequence the tanker remained at a safe anchorage clear of the wreck until the weather moderated. The lengths of suction hose were however placed aboard her while at anchor.

The next morning the sea was calm and mooring operations began, using the L.C.M.[s] as pusher-tugs. By noon this part of the operation had been accomplished and preparations were made to begin pumping. The suction hose was assembled with a double steam-traced inside, lowered to the wreck and attached to the first tank. Pumping commenced at 17:45 and oil began to flow into the tanks of the "IMPERIAL CORNWALL".

At this point it was discovered that the contractor who was to have towed the water barge to and from the "CORNWALL" could not fulfil this obligation. This was countered by dispatching two L.C.M.[s] to Mulgrave and, by securing one on each side of the barge, it was found that it could be moved with comparative ease despite its 90 ton load.

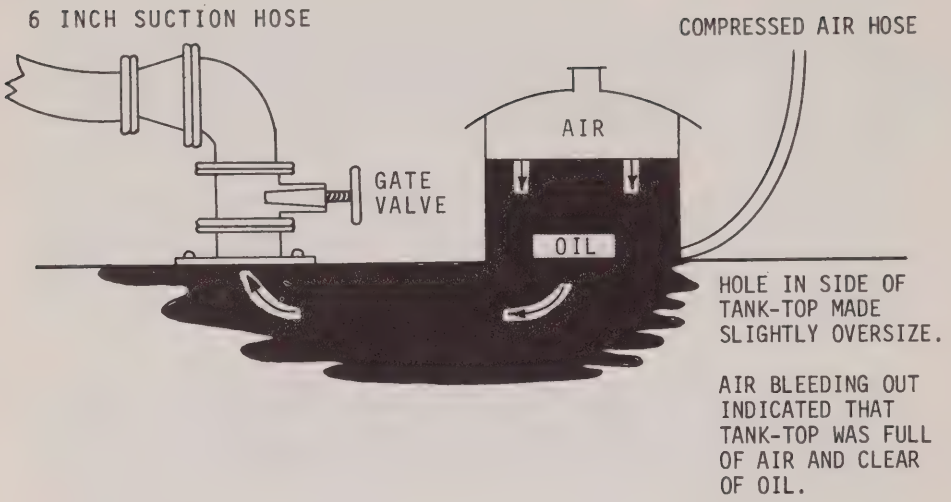
It had been hoped that by using a looped steam-trace, the used steam could be returned to the tanker's feed water tank but due to minor leaks in the flexible steam hose, this return steam had been contaminated by oil and could not be condensed for re-use without the danger of contaminating the entire feed water system. Despite this, the double loop served as a protection against further emulsifying of the oil in the tanks of the "ARROW".

Over the next few days each tank was pumped as necessary. The oil recovered is shown in Appendix 1. No serious difficulties were experienced. While one tank was being pumped the second hose and steam-trace would be secured to the next tank in preparation for pumping. Changing over the hoses at the tanker's manifold, the resumption of pumping on the next tank, could be achieved in less than twenty minutes.

During pumping, it was the procedure for frequent samples to be taken from the spit-cock on the pump. From these it was relatively easy to determine whether it was oil, emulsion, or water coming through the line. This made it possible to compile reasonably accurate statistics. When water first appeared from a tank, the pump was shut down so that oil that had been affected by the cavitation effect at the suction head could consolidate. After a waiting period the pump would be re-started and the flow checked once again to determine its nature. This procedure was followed several times for each tank to obviate the danger of leaving quantities of oil in the "ARROW".

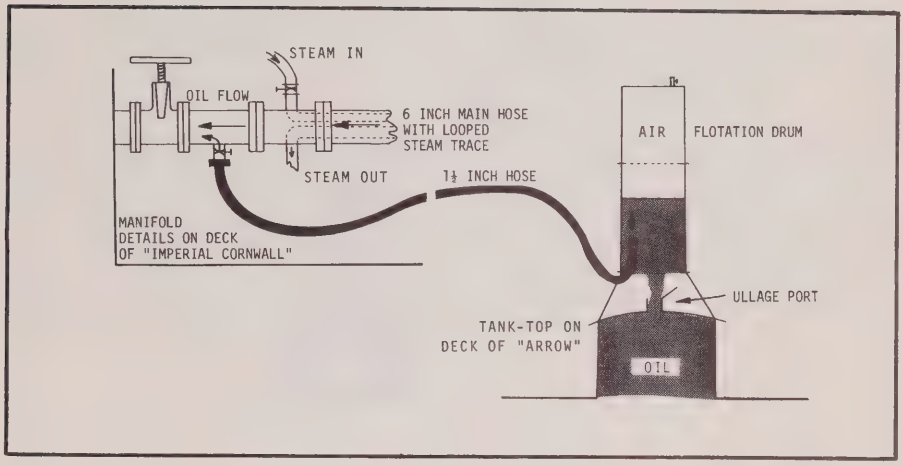
When any one tank had been pumped apparently dry there still remained trapped inside the tank top approximately six barrels of oil that could not be removed as its bottom edge was at deck level, i.e. where the suction was. To remove this oil, several ideas were utilized as a method of stripping.

1. **Compressed Air**



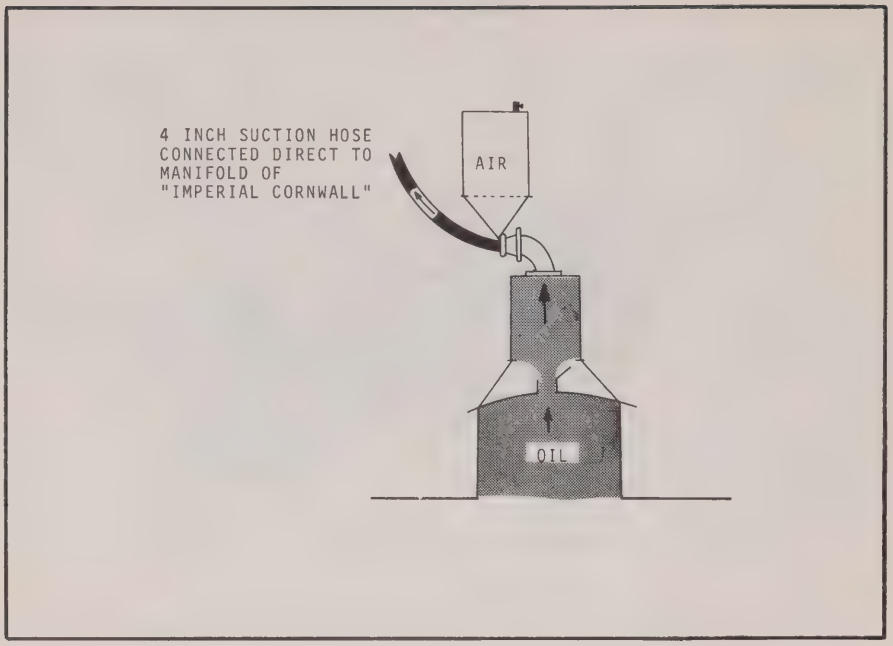
By introducing compressed air into the tank top the residual oil was forced out below the deck and pumped in the normal way. This worked reasonably well, but it was found that all the oil would not reach the suction, with the result that when the air bled out of the tank top this oil would re-enter the tank top. This situation was not satisfactory so another method was tried.

2. Syphon Effect



For this method an open-ended 45 gallon drum was attached to the tank top in an inverted position and kept vertical by a flotation barrel. The end of a one and a half inch bore hose was placed inside the drum and the other end was attached to the suction manifold of the "IMPERIAL CORNWALL". The theory behind this was that oil would be released into the drum by a diver opening the ullage cap until the drum was full and the suction on the main 6 inch hose (not necessarily attached to the tank being stripped), would syphon oil from the drum up the 1 1/2" line. This did work in practice despite the small bore of the hose and the viscosity of the oil, but was an extremely slow process. Accordingly, this method was also discontinued.

3. **Direct Pumping**



Amongst the equipment carried aboard "IMPERIAL CORNWALL" for her own account were found several lengths of 4" light-weight hose. A 90 degree elbow and reducing flange was attached to an open-ended oil drum and one end of the 4" hose attached to the flange, the other end being bolted direct to the suction manifold via another reducing flange. The drum assembly was then secured over the tank-top with a flotation barrel and oil released into it by a diver as before. This method worked well, and was utilized until all tank-tops had been stripped, despite the fact that it was a very messy, clumsy process, resulting in some spillage. Also, the frequent shifting from one tank to another was exhausting and frustrating for the divers.

All the recoverable oil remaining in the tanks of the "ARROW" had been recovered by the early hours of the 17th September. Later that morning, all tanks were sealed off following an inspection in which the ullage caps were lifted, and checks made to ensure that there was no more residual oil. All equipment used was recovered and cleaned off and the "CORNWALL" itself was cleaned up around the working area using steam hoses and peat moss. The contaminated peat moss was loaded into an L.C.M. for disposal at the dump-site in Port Royal.

At 1700 hours on the 17th of September the "IMPERIAL CORNWALL" was slipped from her moorings and proceeded on her way to discharge her cargo at Dartmouth.

After a day of cleaning equipment, YMT 11 proceeded to the wreck site and over a period of a day and a half did another survey on both the stern and bow sections of the "ARROW". No evidence of oil leaks was found at the stern and no recoverable oil was found in the bow section, which was breaking up quite rapidly. In this connection, the "Monkey Island" radar mast which had previously been the only portion of the bow section visible above water had fallen in the early hours of the 11th September.

The chain moorings and buoys were recovered by the "SIR WILLIAM ALEXANDER" on September 20th and YMT 11 left for Halifax the same day. The water barge YSW 219 had been taken in tow for Halifax on the previous day by the Dockyard tug "ST. CHARLES".

Operation Scour had therefore come to a successful conclusion, and it is very apparent that techniques for the underwater recovery of oil developed earlier had again been proved feasible. It has also been demonstrated that the capability and equipment to undertake this type of operation can be found in Canada, and with further development and continuing co-operation between Departments of Government, both Federal and Provincial, this capability and knowledge can be expanded to cover a multitude of situations and degrees of control concerning the pollution of our natural environment whether this occurs at sea or on inland waters.

Appendix I

"ARROW"

SECOND PUMPING TOTALS – (Bbls)

9th – 17th Sept. 1970

FIGURES OBTAINED ON SITE VIA

ULLAGES OF "IMPERIAL CORNWALL" TANKS

Tank	"Oil"	WATER AND EMULSION	TOTAL	CUMULATIVE TOTAL	DATES
6 Port	Open	–	–	–	–
Centre	Open	–	–	–	–
Starb'd	56	240	296	296	14/15 Sep
7 Port	26	50	76		16 Sep
Centre	36	110	146	518	14 Sep
Starb'd	41	130	171	689	15 Sep
8 Port	766	285	1051	1740	9/10 Sep
Centre	86	260	346	2086	13/14 Sep
Starb'd	583	496	1079	3165	11/12 Sep
9 Port	6	25	31	3196	17 Sep
Centre	96	210	306	3502	14 Sep
Starb'd	6	25	31	3533	17 Sep
10 Port	767	350	1117	4650	10/11 Sep
Centre	Open	–	–	–	–
Starb'd	622	300	922	5572	12/13 Sep
TOTALS	3091	2481	5572	5572	9/17 Sep

The average water content of "oil" recovered from the "ARROW" was 15%. This alters the figures obtained on board "IMPERIAL CORNWALL" as follows:

BUNKER C	2628 Bbls.
WATER	2944 Bbls.
TOTAL	5572 Bbls.

Holding tank figures obtained from Imperial Oil Limited indicate that a total of 6010 barrels was discharged from "IMPERIAL CORNWALL". The discrepancy of 438 barrels between the two totals is due to the fact that no attempt was made to ullage what was obtained from the tank tops. It was known that each tank top had a capacity of 6 barrels so this figure was added to the totals already obtained. In the event, however, an appreciable amount of water was pumped at each tank top due to cavitation.

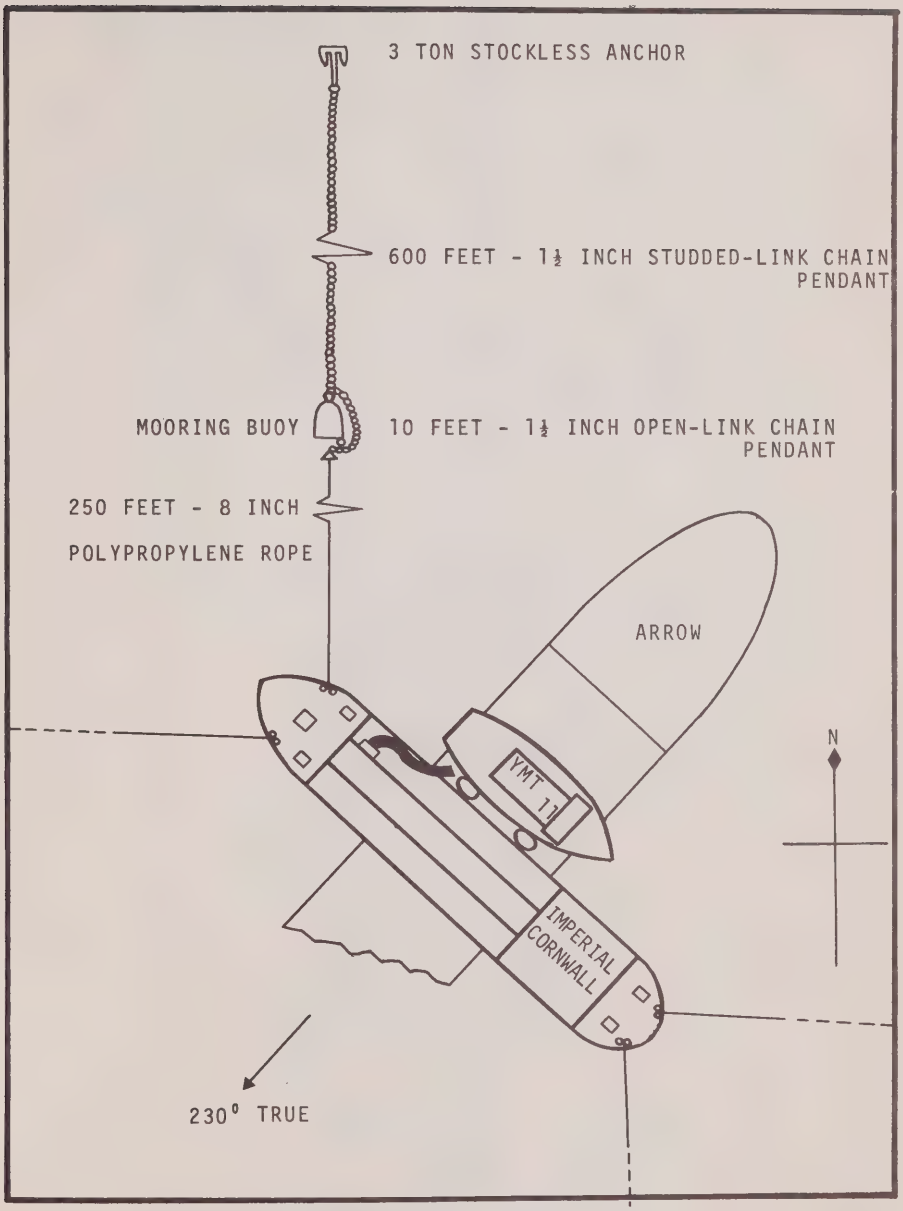
Once in the holding tank the recovered oil and water was settled out at a temperature of 150°F. It was also treated with a chemical emulsion breaker, (Brexit 8007), and the totals were then,

BUNKER C	2700 Bbls.
WATER	3310 Bbls.
TOTAL	6010 Bbls.

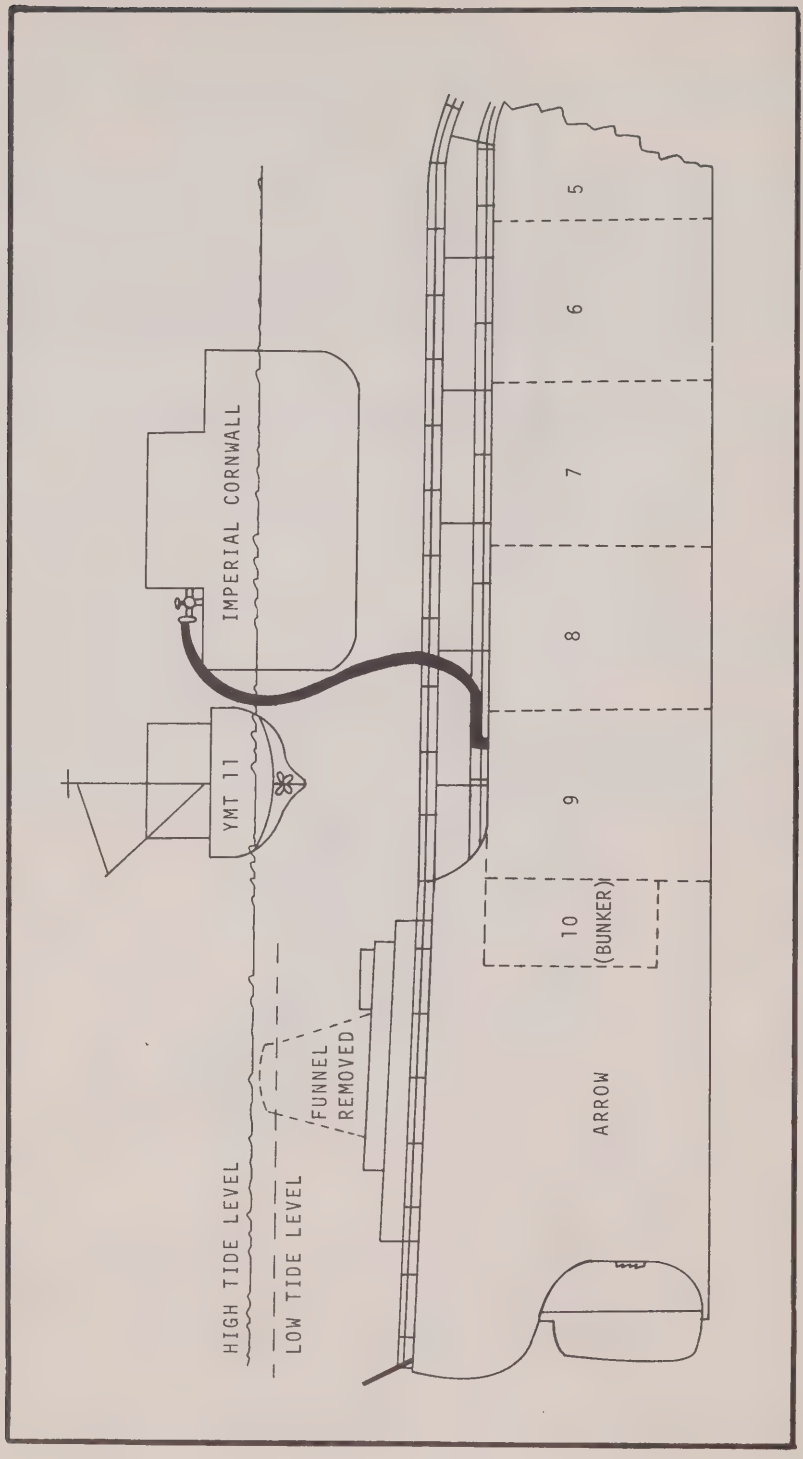
The 2700 barrels of Bunker C had a water content of 4%, (as against the normal 1 1/2 – 2%), but this would be reduced by blending.

Correcting this 2700 barrels by 4% to compare figures results in a total of 2592 barrels recovered and indicates an error of 36 barrels in the totals obtained during pumping.

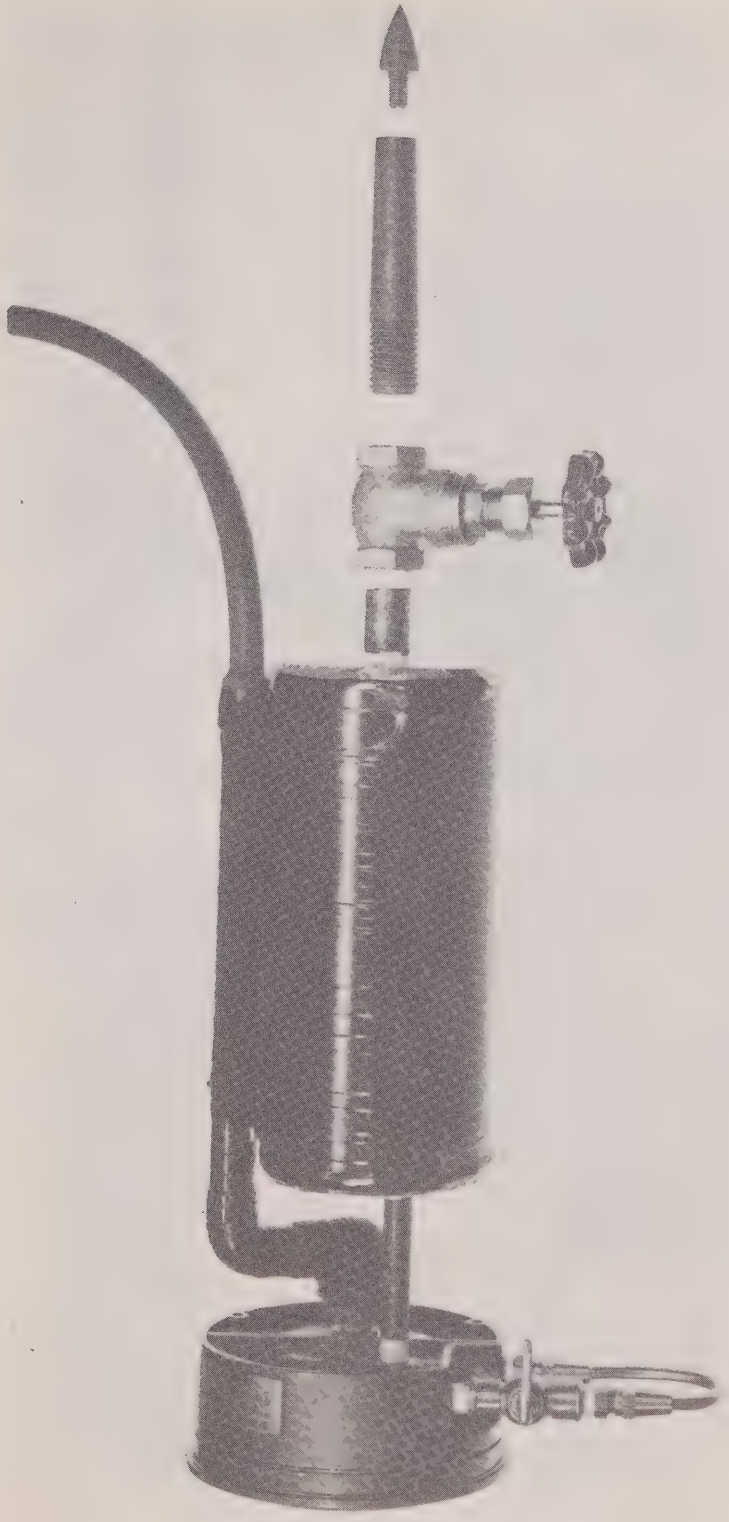
Appendix 2



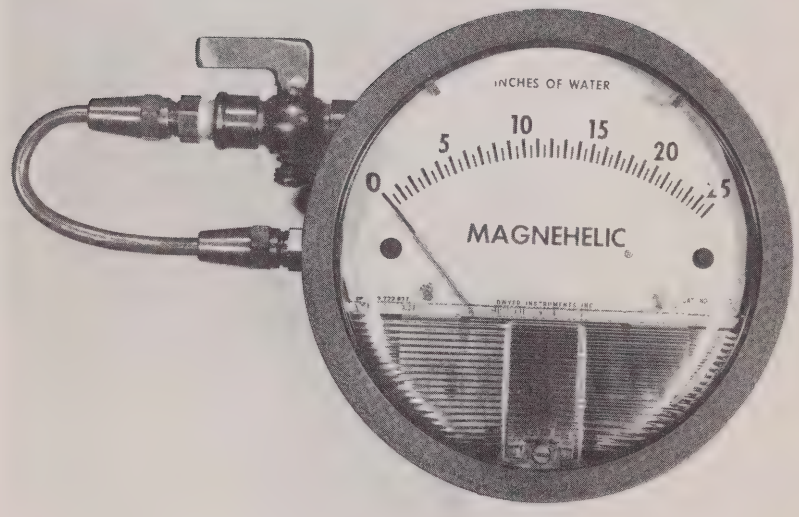
MOORING CONFIGURATION – PLAN



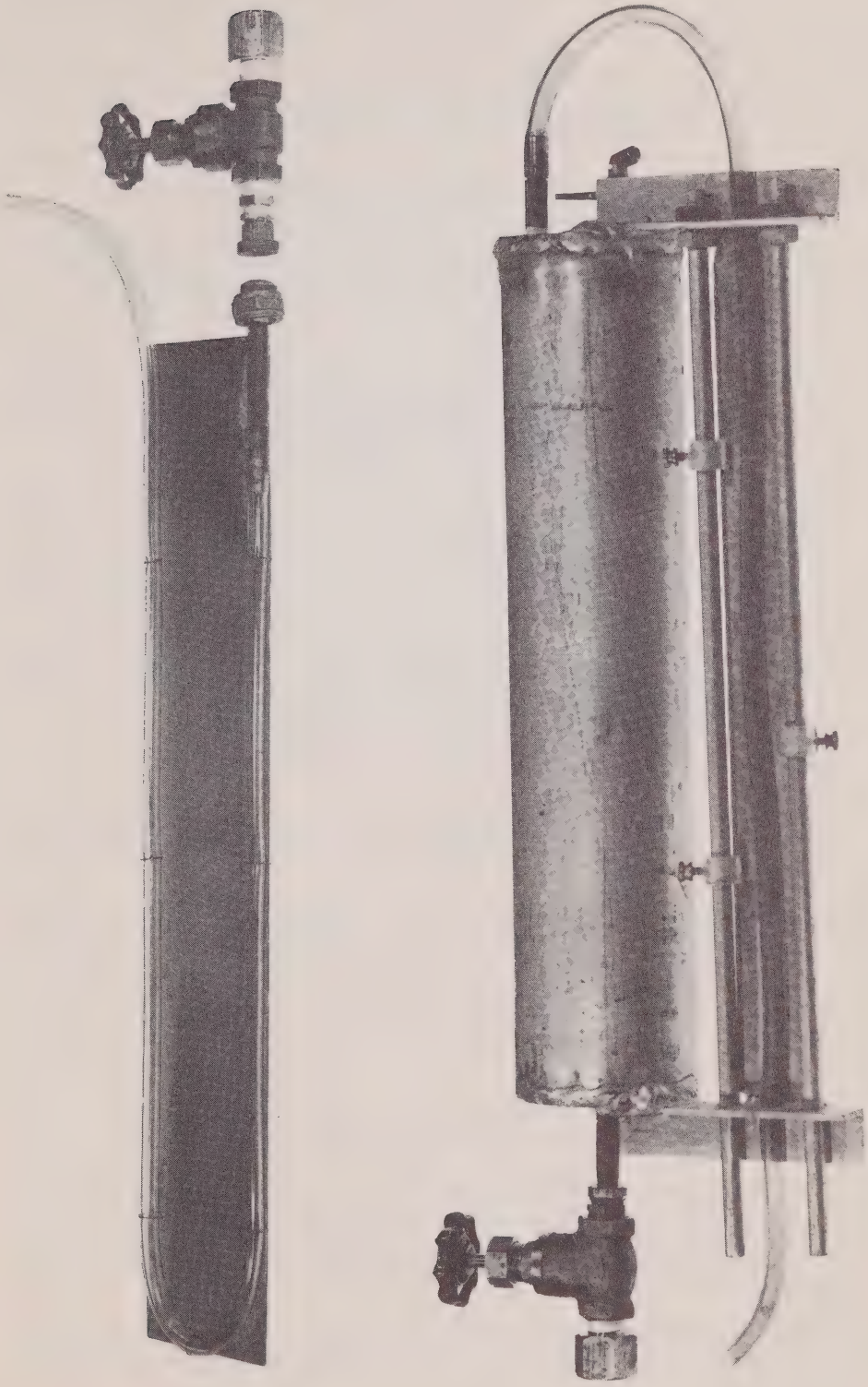
MOORING CONFIGURATION – ELEVATION



MAGNEHELIC GAUGE – SIDE VIEWS



MAGNEHELIC GAUGE – TOP VIEW



MANOMETER GAUGES

Appendix 5

OPERATION SCOUR

PLANNED SCHEDULE OF EVENTS

30 August YMT 11 with diving team proceeds to Arichat

31 August to 4 September (as convenient) "IMPERIAL CORNWALL" loads the following at Shearwater jetty: 6 inch oil hose (250 ft.), 2 inch steam hose (650 ft.), 4 mooring lines (8 inch circ. polypropylene), two pneumatic fenders (Shearwater jetty crane required).

31 August to 2 September YMT 11 moors over "ARROW", lays four marker buoys to locate positions for heavy moorings. Commences fitting gate valves and elbows, and drilling on port bunker. "SIR WILLIAM ALEXANDER" loads four moorings at Shearwater jetty; then proceeds to Chedabucto Bay (jetty crane may be required).

3 to 4 September "SIR WILLIAM ALEXANDER" lays anchors in positions indicated by marker buoys (elliptical floats) and stretches cables and moorings toward "ARROW" position, assisted by YMT 11 and DOT landing barges as requisite. "SIR WILLIAM ALEXANDER" also lays one mooring buoy with concrete anchor in Arichat Harbour approaches. YMT 11 will re-position this mooring in lee of Jerseyman Island to provide sheltered berth during SW winds.

5 to 7 September Diving team continue fitting valves and elbows, preparing for oil removal. "IMPERIAL CORNWALL" sails for Chedabucto Bay so as to arrive A.M. 8th September.

Water Barge YSW 219 towed to Mulgrave; to arrive 8th September.

8 September YSW 219 arrives at Mulgrave and taken into custody of contractor for transporting fresh water to "IMPERIAL CORNWALL". (estimated water requirements are 20 tons per day).

8 to 18 September REMOVAL OF RESIDUAL OIL FROM "ARROW" – When "CORNWALL" is moored, two 6 inch oil hoses, with a steam trace within each, will be attached successively to all cargo and bunker tanks containing oil. "CORNWALL" will also provide steam for injection into the oil via the steam trace. As tanks are cleared of oil, hoses and valves will be removed, and blanking plates fitted by divers. DOT landing barge crews will assist in handling oil hoses, etc. in "CORNWALL".

8 to 18 September YSW 219 will be moved by contractor between Mulgrave and "IMPERIAL CORNWALL" as required (estimated every 2nd or 3rd day).

18 to 25 September On completion of removal of oil from "ARROW" "CORNWALL" will unmoor and proceed to Imperial Oil and disembark cargo. Oil hoses, moorings, etc., will also be off loaded at Shearwater jetty. Divers will complete removal of valves, etc., and fitting of blanking plates. On completion, team will recover all gear and YMT 11 will return to Base.

18 to 25 September "SIR WILLIAM ALEXANDER" recovers all moorings during this period (as convenient). The four heavy moorings to be landed at Shearwater jetty.

VOLUME IV

APPENDIX E

OPERATION OF NET LAUNDRY

FOR OIL CONTAMINATED FISHING GEAR

1970

REPORT FOR

SCIENTIFIC CO-ORDINATION STAFF
CLEAN-UP TECHNOLOGY GROUP
TASK FORCE – PROJECT OIL

BY

J.B. MYRICK

FISHERIES SERVICE
CANADA DEPARTMENT OF FISHERIES AND FORESTRY
INDUSTRIAL DEVELOPMENT BRANCH

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1 SUMMARY

Equipment designed by the Scientific Coordination Staff, Clean-Up Techonology Group, Project Oil, and manufactured by Ferguson Industries Limited, was used to successfully cleanse purse seine nets which had been contaminated with Bunker "C" spilled from the oil tanker ARROW in Chedabucto Bay.

This report discusses the design and operation of the equipment as it is installed at Point Tupper, Nova Scotia. Suggestions are made for improving the efficiency of the unit.

2 INTRODUCTION

On March 19, 1970, Dr. W.D. Jamison, W.A. Gibson and J.B. Myrick, met with Dr. P.D. McTaggart-Cowan and the Project Oil Task Force. The purpose of this meeting was to present to the Task Force, on behalf of the Clean-Up Technology Group, Scientific Co-ordination Staff, a proposed system for cleaning oil contaminated fishing gear.

The proposal was accepted as presented (Appendix I & II), and the Task Force immediately commissioned Ferguson Industries Limited of Pictou, Nova Scotia to construct the required equipment. Mr. W.A. Gibson, Engineer with the Scientific Co-ordination Staff, was asked to work with Ferguson Industries on the project.

On April 5, 1970, at the request of the Task Force, I proceeded to Port Hawkesbury to assist Mr. G.A. Bezanson of D.R.E.A. with the installation of the equipment and to assume responsibility for the operation of the net laundry on behalf of the Department of Fisheries and Forestry.

The first contaminated fishing gear, a seine net from the herring seiner, PIERRE HELENE, was cleaned successfully on April 10, 1970.

3. CLEANING PLANT

3.1 Design

The plant is designed to provide three main functions, first, a steaming operation in which the congealed bunker oil is heated to a point at which it will drip from the coated gear, and where the gear is mechanically cleaned by the action of live steam, second, a degreasing process in which gear is immersed in a tank containing an appropriate solvent, and third, a warm water rinsing operation to remove the residue of the degreasing solution.

The complete plant as originally designed included facilities for handling the gear, supplying steam and water, etc.

In this particular operation, the plant is located adjacent to the Nova Scotia Power Commission's Thermal Generating Plant at Point Tupper, Nova Scotia. Steam and water are readily available, eliminating the need for a self-contained steam generator and high volume water pump.

3.2 Equipment

The steaming and flushing chambers are identical (Photos 403 and 416) and are cylinders 4 feet in diameter and ten feet long, constructed of 5/16" steel plate. Steam and/or water is admitted through 70 - 5/16" holes spaced evenly in ten rows along the length of the cylinders, and are fed by headers on the outside. Drainage is through a series of 4" diameter holes in the bottom of the cylinders, and the effluent is carried to the ends of the cylinders in a trough welded to the outside. A 1/2 inch thick neoprene diaphragm is installed at each end of the cylinders. In the steaming unit, the steam supply is connected directly to the headers, and in the flushing unit a two inch water line is connected, with steam introduced to the stream through an aspirator immediately before entering the headers. (Photo 0-416).

The degreasing tank is made of steel plate, and is 5 x 5 x 12 feet at the top, with sloping ends. A 6 inch diameter roller is provided at each end of the tank at the top, and two more are installed near the centre below the level of the degreasing solution. The solution is heated by a steam coil, covered by a perforated plate, near the bottom of the tank.

A model 31B Marco Power Block (Photo 0-413) was originally mounted on a frame about 6 feet from the flushing chamber (Photo 0-416). However, this did not allow enough of a net to be wrapped around the sheave for maximum pull and it is now mounted on a 6 ton Bantam Crane. This arrangement allows much greater flexibility and it can be used to load a net on a trailer truck.

Hydraulics for the power block are provided by a power unit (Photo 0-414) consisting of a 37 H.P. Lister air-cooled diesel engine directly connected to a hydraulic pump. It is complete with oil reservoir, strainer, and control valve. Provision is made on the base of this unit for a high volume water pump should it be required. A 3/4 inch bronze gear pump mounted at the front of the engine is used to transfer oil and detergent, and is controlled by a removable belt.

3.3 Degreasing Solution

The basic ingredient of the degreasing solution is Cody's HC Degreaser. This is normally mixed with diesel oil in the proportion of 1 part degreaser to 4 parts diesel oil. However, for the first "filling", we used 225 gallons of Cody's Degreaser, 550 gallons of diesel oil, all that was available from the delivery truck, and 400 gallons of #1 stove oil.

3.4 Steam and Water Supply

Steam at 185 lbs. pressure is taken from the 30 inch line that supplies the heavy water plant from the Thermal Plant. It is conducted through 150 feet of 2 inch 200 lb. test steam hose (Photo 0-403) to a header where it is distributed through 1 inch steam hose to each unit of the net laundry. Water at approximately 40 lbs. pressure is supplied to the flushing unit directly from the Thermal Plant through 2 inch iron pipe.

4. OPERATION

4.1 Procedure

The arrangement of the basic units, as used, lends itself very well to a continuous operation. It worked satisfactorily for the three seine nets and heavy lines cleaned in this equipment.

When cleaning the first two nets, the trailer truck was backed up to the steaming chamber and the net fed directly to it over an aluminum chute (Photo 0-403). The net, which was trucked from Pubnico, was piled differently on the truck, and considerable difficulty was encountered as the net had to be pulled from the side of the truck. Of the three nets handled, the net from the PIERRE HELENE was piled on the truck bed from side to side at the front of the truck bed until a bulk was formed, then another bulk until the back of the truck was reached (Photo 0-399). This arrangement allowed the easiest removal of the net from the truck. Great care must be taken in handling the net so that it does not tangle or get caught and tear. Even the smallest projection will snag the net.

In the steaming operation, the net is well warmed, being hot to the touch. Very little bunker oil appeared to be removed in this part of the operation, which can probably be attributed to the fact that the net is fairly tightly compacted as it is pulled through the cylinder.

The degreasing unit is effective in removing the bunker oil, especially when the solution is heated. There is no control, other than a shut-off valve on the steam line, to regulate the temperature of the solution, and at no time is it heated to a degree above which the tank feels hot to the touch. This should be below the flash point of the solution. Some agitation is helpful in removing heavy deposits of oil, and a sump pump was purchased to accomplish this. However, the pump has an open type motor, and it is not used because of the fire hazard due to the hot solution. The solution, which was mixed with part stove oil, as on the first run, appeared to give the best results. Even this mixture loses its effectiveness as bunker oil is dissolved, and the solution was changed after the first run. The second net was constructed of heavier twine and was very dry. Considerable solution was absorbed by this net and carried out of the tank. In this instance, the level was maintained in the tank by adding proportional amounts of degreaser and diesel oil during the operation. A third net was cleaned before the second batch of solution was completely changed. Some of the solution, which is carried out of the tank on the net, drips onto the ground where the net passes over the top roller.

The final stage of the cleaning operation is accomplished in the flushing cylinder, where the warm water sprays form an emulsion with the residual solvent on the net and is flushed out as effluent. What residue remains on the net is not objectionable to the fishermen, and will probably be completely removed the first time the net is fished. The sprays near the top of the cylinder have very little force as the restriction in the inlet to the headers where the steam injector is located causes a drop in pressure. When the 7 inch and 10 inch polypropylene lines from the barge, IRVING WHALE, were run through the laundry, flushing was inadequate as it was impossible to position the rope at a point where the sprays are concentrated. According to Mr. Harry Taylor, General Manager of the Thermal Generating Plant, water consumption is approximately 6,000 gallons per hour.

The Marco Power Block is used to haul seine nets and heavy rope through the units. The smooth design of the sheave on this power block does not provide adequate pulling power especially when it is wet. Although little difficulty was experienced with the net from the PIERRE HELENE, the other nets required assistance aside from the power block to drag them through the unit. This was accomplished in two ways. When the second net, from the herring seiner BLUE WATERS, was cleaned, a sling was passed around the net where it left the flushing chamber and a line was led from this to a truck with a winch which was used to pull the net, with the power block taking up the slack. About 30 feet of net could be pulled through before the sling was repositioned and the operation repeated. A similar process of pulling the net in hitches was used on the third net, except that in this case the boom of the crane, which supported the power block, was lowered and the line from the sling was passed over the sheave with the net and the end fastened to the crane. When the boom was raised the tightening of the line gave the added pull needed.

Several large valves and fittings were cleaned by simply lowering them into the warm degreasing tank with the help of the mobile crane. They were flushed with steam and water while suspended from the crane. Small nets and pot warp could best be cleaned using this "batch" method. The cylindrical flushing unit is not adaptable to this type of operation. A dip tank, perhaps in combination with sprays, should be suitable.

4.2 Effluent

The emulsion formed by the water – degreaser – dissolved bunker oil mixture makes up most of the effluent. The volume of effluent in an eight hour period is approximately 50,000 gallons. This effluent is allowed to run onto the ground where it finds its way to a ditch which runs back of the Thermal Plant. Some degreaser-oil solution drips from the net before it enters the flushing unit, and this does not appear to emulsify without vigorous agitation, such as the action of the sprays in the flushing cylinder. This oily solution floats away on the surface of the flush emulsion. A small dam in the drainage ditch, constructed of an old fishing net, serves to collect this surface oil, where it is absorbed by the use of peat moss. The small amount of condensed steam and bunker oil from the steaming chamber is collected in barrels. When the degreaser solution becomes thick with bunker oil and loses its effectiveness it is pumped into barrels and trucked to an approved dump site.

4.3 Personnel

Aside from supervision provided by the Department of Fisheries & Forestry, a foreman and one labourer are employed to maintain the plant. An operator is provided with the rental of the crane when it is required. This small staff can operate the plant when cleaning smaller fishing gear, pipe fittings, etc., and provide maintenance and clean-up operations. Extra manpower is used for loading barrels of waste, etc., when necessary. When the large seine nets are cleaned, a minimum of seven extra hands are required to handle the net. When the first two nets were cleaned, the crews of the vessels provided this help. When the third net was cleaned, local help was procured. This proved to be most unsatisfactory as they lacked experience in handling this type of fishing gear. In this instance, we were fortunate in having the services of Fisheries Officer Joseph Arsenault to direct the operation.

4.4 Safety Measures

As the heated degreaser solution is a volatile mixture, four "Foamite" fire extinguishers are placed nearby ready for instant use (Photo 0-416). Considering the danger involved in the use of a crane to support the Power Block and lift heavy valves, etc., all personnel are required to wear hard hats while on the job site.

4.5 Cost Estimate

The approximate cost of cleaning the net from the herring seiner, PIERRE HELENE, is summarized as follows:

H C Degreaser	$1,000.00
Diesel Oil	200.00
Crane Rental	200.00
Floats & Tandam Truck Rental	220.00
Labour (including loading and unloading of net and cleaning boat deck	860.00
Clean-up and waste disposal	120.00
TOTAL	$2,600.00

Cost of steam and water is not included as it was provided free of charge.

5. RECOMMENDATIONS

5.1 Design

Observations would indicate that the steaming and flushing cylinders are larger than necessary. A diameter of 3 feet would be more practical, and would permit a more concentrated and vigorous action to the live steam and flushing sprays, yet allow passage of the large seine nets.

A longer decreasing tank would allow a longer immersion cycle. The capacity need not be enlarged as the tank could be narrower and shallower. The rollers should be of larger diameter, and, in a longer tank, could be spaced farther apart thus offering less resistance to the passage of the net. Considerable drip occurs at the end of the tank where the net passes over the roller, and is lost on the ground; this roller should be placed inside the edge of the tank, or a trough could be constructed so that the drip is caught and returned to the tank before the net enters the flushing cylinder.

Agitation should be provided in the tank. This could be accomplished by the installation of a suitable propeller or pump directing a stream of degreaser solution on the nets.

When the sheave on the power block is wet, its pulling power is diminished due to slippage. A Power Block with a cleated sheave, (Photo 0-401) such as used on the PIERRE HELENE, would overcome this problem. A second power block to lift the net from the truck bed and feed it to the steaming chamber would relieve the load and permit the operation to proceed without the aid of extra winches, etc.

5.2 Degreaser

More information should be obtained as to the best formulation of degreaser and solvent to give the most efficient cleaning action. In the experience gained so far, it would appear that using a lighter, more volatile, vehicle, such as No. 1 stove oil, is more effective. This is affirmed in the report, "Report on Net Cleaning Experiment of Bunker "C" Oil in Chedabucto Bay" by Claude Wallace of his experiments. It would also be advantageous to be able to determine when the solution has lost its effectiveness, and ways of reclaiming contaminated degreaser solution.

5.3 Effluent

Although the distributor of Cody's H C Degreaser assures us that their product is degradable, we know little about the polluting effects of the emulsified effluent from the flushing tank. Studies should be undertaken to determine the best way to handle this effluent.

One possible method might be to dig a large settling basin. If the emulsion breaks down, the oil could be skimmed from the surface and the effluent recirculated, probably through a polyurethane filter.

6. ACKNOWLEDGEMENTS

The following persons were concerned with the Laundromat Project:

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Messrs. Bezanson, Myrick, Magill
Canso Excavators Ltd.

Photographs: T. Galley

APPENDIX 1
PROJECT OIL

Scientific Co-ordination Staff
Clean-Up Technology Group

PROJECT: SYSTEM FOR CLEANING OIL-CONTAMINATED FISHING GEAR

OBJECTIVE: To design a system which will clean acceptably any type of fishing gear likely to become contaminated with Bunker "C" Oil (or Bunker "C" derived water-in-oil emulsion) should the gear be used in the normal way in the Chedabucto Bay area during the next year.

Limited Criteria

(a) The system shall be either mobile and designed to operate in Chedabucto Bay area communities or shall be such that it can be built and sited in one or more Chedabucto Bay area communities.

(b) The system shall not assume either water or sewer services will be available.

(c) The system shall clean all types of fishing gear while minimizing inconvenience to fishermen. In particular, the system should not require dismantling of any of the usual fishing gear assemblies.

(d) The system shall tolerate such non-oil contaminants as stones, sand, seaweed, etc.

(e) The system shall not damage painted surfaces or be likely to discolour or stain textiles or plastics.

(f) The system shall clean acceptably materials such as nylon (monofilament or braided twine), wood, polypropylene, metals, styrofoam, rubber, cotton.

(g) Acceptability

(i) Where fish or lobster "avoidance" of gear is a factor, there shall be no residual film of oil or cleaning materials.

(ii) In other cases, a residual thin film of oil or cleansing materials is acceptable if not likely to affect operation or effectiveness of gear or offend fishermen.

PROPOSED SYSTEM: The proposed system is shown in the attached sketch. A unit operations approach has been used. Only the first unit need be used in cases where steam-cleaning proves acceptable.

A rough cost estimate (Total – $26,000) for one such plant and its auxiliary equipment is also appended.

EXPERIMENTAL TESTS AND RESULTS: The design proposed is consistent with results of laboratory-scale experiments conducted at N.R.C.L. Halifax and pilot-pant dry-cleaning trial conducted at a commercial dry-cleaning plant in Halifax.

Conventional dry-cleaning is the best method for both nylon and polypropylene, but some fishing gear materials (e.g. plastic floats, styrofoam) are incompatible with the process. This incompatibility requires disassembly of many common fishing gear arrays.

No detergent-water systems tested cleaned polypropylene or nylon acceptably. More than 12 different systems were tried.

Steam-cleaning yields acceptably clean gear in most cases where fish or lobster "avoidance" of gear is not a factor.

The system proposed recommends a specific cleanser-emulsifier/diesel fuel formulation. This is based on the laboratory-scale experiments and further consultation with the senior chemist of the firm which makes the cleanser/emulsifier.

CONCLUSIONS: The system proposed meets the project objective, and in the opinion of project staff, satisfied all criteria stated.

PROJECT STAFF: For the Scientific Co-Ordinator: Dr. W. D. Jamieson, W.A. Gibson
For Dept. of Fisheries & Forestry: H. D. Johnston, J.B. Myrick
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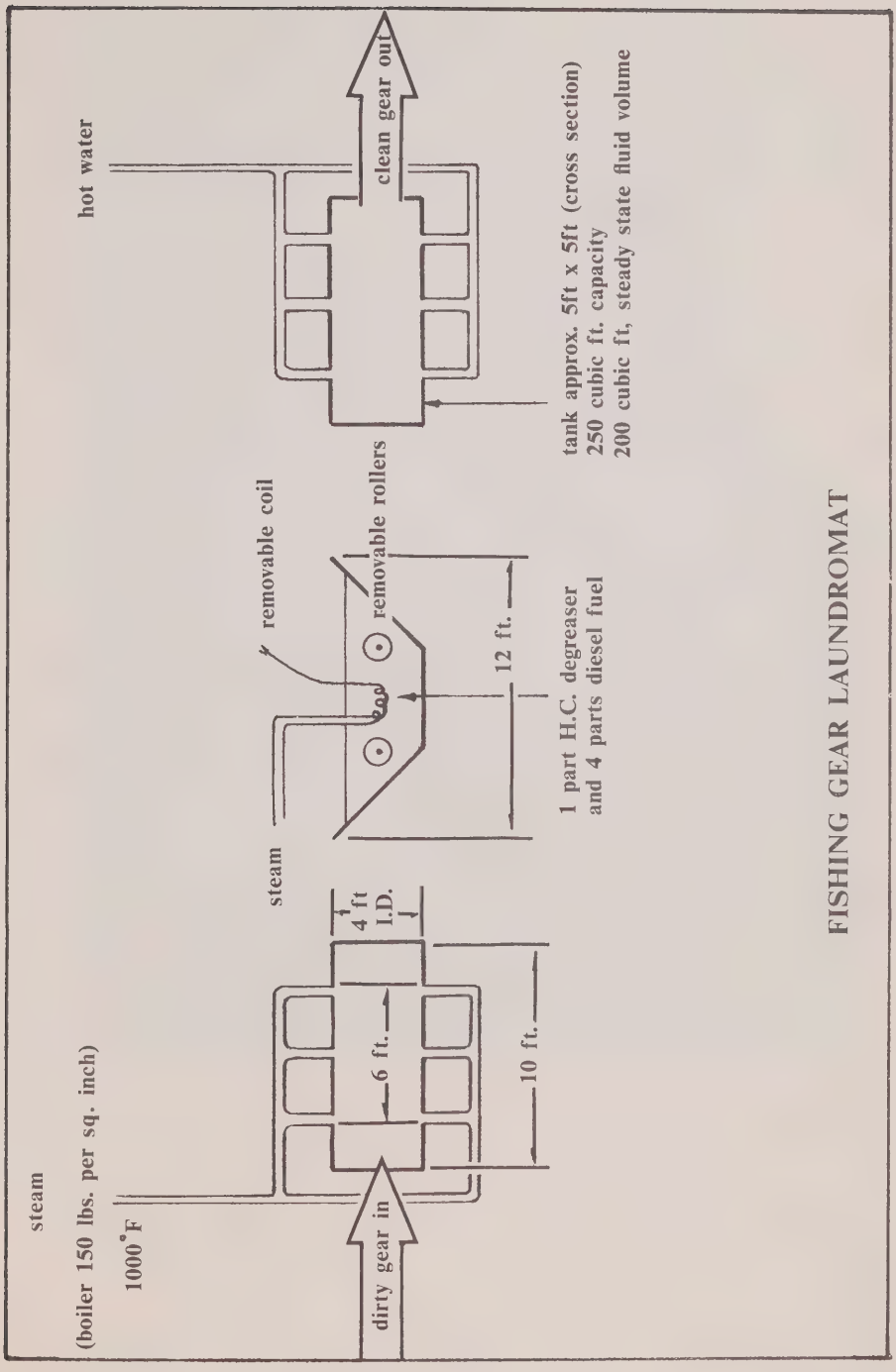
Appendix 2


steam
(boiler 150 lbs. per sq. inch)
1000°F
dirty gear in
6 ft.
4 ft I.D.
10 ft.
steam
removable coil
removable rollers
12 ft.
hot water
clean gear out
1 part H.C. degreaser
and 4 parts diesel fuel
tank approx. 5ft x 5ft (cross section)
250 cubic ft. capacity
200 cubic ft, steady state fluid volume
FISHING GEAR LAUNDROMAT

APPENDIX 3

AOL DRT

DND PTHWKS
R 121345Z APR 70
FM DR. MCTAGGART-COWAN, PORT HAWKESBURY
TO DR. D. JAMESON, OPERATION OIL,
BEDFORD INSTITUTE

CONGRATULATIONS TO YOU AND YOUR TEAM ON THE SUCCESSFUL OPERATION OF THE LAUNDROMAT. FIRST SEINE NET WAS CLEANED FRIDAY AND THE RESULTS DELIGHTED ALL INCLUDING THE SHIPS CAPTAIN. NET MEASURED 325 BY 42 FATHOMS, WEIGHED 11 TONS AND TOOK SIX HOURS TO PROCESS.

DND PTHWKS

AOL DRT

Loading the seine net from the PIERRE HELENE for transport to the net laundry. **O-400**

Method of loading the trailer truck, showing net piled in "bulks". **O-399**

Net floats heavily contaminated with Bunker "C". The Marco Power Block used on herring seiner, PIERRE HELENE, showing cleated sheave. **O-401**

Trailer in position for unloading. Steaming chamber and Degreasing Tank at right of picture. Steam supply hose in foreground crosses ditch which carries away flushing effluent.

O-403

Flushing cylinder showing steam and water connections. Steam obscures the steaming cylinder during operation. Power block was originally mounted on frame in foreground. "Foamite" extinguishers at right of picture.

O-416

Diesel operated power unit, showing hoses supplying hydraulic fluid to the Marco Power Block.

O-414

Marco Power Block, mounted on Bantam Crane, in position used during operation. **O-413**

Crew member from seiner PIERRE HELENE piling the net as it comes from the power block during operation. Whiteness of floats proves efficiency of cleaning operation. **O-415**